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MEASUREMENT AND ANALYSIS OF NOISE FROM SEVENTEEN AIRCRAFT IN LEVEL FLIGHT (MILITARY, BUSINESS JET, AND GENERAL AVIATION)

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16. Abstract

Measurements of noise from aircraft level flyovers are presented in the form of effective perceived noise level (EPNL) as a function of slant range at the closest point of approach. Seventeen aircraft were investigated (various military, business jets, and general aviation types) and the effort involved acquisition of acoustical, meteorological, aircraft tracking, and aircraft operational data. Microphones were located near the ground in an array normal to the flight track. All tests were conducted at the Pendleton Municipal Airport, Pendleton, Oregon, during two separate time periods in July and October 1970.

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LIST OF SYMBOLS

Symbol	Definition	Unit
X	Horizontal distance perpendicular to runway centerline	feet
Y	Distance from reference point along runway centerline	feet
Z	Height above reference point	feet
SR	Distance from aircraft to microphone at closest point of approach	feet
β	Angle between ground plane and slant range to aircraft	degree

INTRODUCTION

In an effort to obtain information to serve as a data base for the effective perceived noise levels of noncommercial jet and turboprop aircraft, a series of tests were conducted at Pendleton, Oregon, in July and October 1970.

The July tests recorded the noise levels of the Cessna 182, 337, 210, and Piper Cherokee propeller-driven aircraft and T-33 military aircraft. The noise from two level flybys, at altitudes of 100, 700, and 1500 feet for each aircraft except the T-33, were recorded on the ground at distances of 500, 1000, 5000, and 2000 feet perpendicular to the line of flight. The T-33 flew at altitudes of 100, 700, 1500, and 2000 feet above the ground. The October tests recorded the noise levels of military and business jets from level flybys at altitudes of 6000, 1000, and 200 feet. Measurement sites on the ground were at distances of 110, 500, 1000, 1500, 2000, 2500, 3000, and 3500 feet perpendicular to the flight path. The aircraft were tracked using an MPS-19 radar operated by a crew from Edwards Air Force Base, California, and by a portable theodolite system operated by a crew from the National Aviation Facilities Experimental Center, Atlantic City, New Jersey. Meteorological data was acquired by a crew from EG&G Environmental Division.

The test conditions and details of measurement instrumentation used in obtaining the acoustic, meteorological, tracking, and aircraft performance data are discussed in the following sections.

APPARATUS AND METHODS

AIRCRAFT DESCRIPTION

The general description of each aircraft tested is given in Table I. The test gross weights of the military aircraft were all somewhere below maximum takeoff gross weight since these aircraft were deployed from their home base. The nonmilitary aircraft flybys were started at or near the maximum takeoff gross weight.

FLIGHT PROFILE DESCRIPTION

Flight procedures utilized straight and level flybys down the centerline of the runway. Each flyby was started upon reaching a VOR marker approximately 3.6 n.mi. from the beginning of the runway and terminated over the outer marker 4.1 n.mi. from the end of the runway. A racetrack pattern was used. October flyby altitudes were 6000, 1000, and 200 feet above the nominal field altitude of 1500 feet mean sea level (MSL). The October tests were performed in the sequence outlined in Table II. The July tests were performed in the sequence outlined in Table III.

ACQUISITION OF OPERATIONAL DATA

The operational data acquired consists of aircraft performance parameters and tracking information. During the course of each flyby, the pilot noted such parameters as aircraft weight, outside air temperature, percent power, and indicated airspeed.

The aircraft space positioning performance was obtained by tracking the aircraft with a radar and a phototheodolite system.

The radar, a modified MPS-19, is shown in Figure 1. Radar tracking outputs consisted of digital tapes and analog plots of the X, Y, and Z coordinates of the aircraft. Since the aircraft was not instrumented with a beacon, the aided tracking mode was utilized. This mode of operation was visual tracking of the aircraft with the aid of a long-range television camera. Aircraft range was obtained from skin reflection. The selected visual point of reference was the aircraft wing root.

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Table I. Aircraft Description

Aircraft	Engine	Total Maximum Power at Sea Level (lb thrust)	Nominal Gross Weight (lb)
A-4C	P&W J52-P-8A	9,300	24 500
A-6A	P&W J52-P-8	9,300	60,600
F-8K	P&W J57-P-20	18,000	29,500
F-102	P&W J57-P-23	18,000	27,000
F-101	P&W J57-P-55	16,900	51,000
F-4	GE J79-GE-8	17,000	56,000
A-7B	P&W TF30-P-6	11,350	42,000
C-141A	P&W TF33-P-7	21,000	318,000
T-33	J33-A-35	5,200	12,000
Learjet	GE CJ610-6	2,950	13,500
Jet Commander	GE CJ610-1	2,850	20,000
Sabreliner	P&W JT12A-8	3,300	20,300
DC-9	P&W JT8D-9	14,500	77,700
Cessna 182	Con 0-470-R	230 hp	2,950
Cessna 210	Con IO-520A	285 hp	3,800
Cessna 337	Con IO-360-C	210 hp	4,630
Cherokee 6	Lyc 0-540-E4B5	260 hp	3,400

The phototheodolite units were comprised of two Ackley cameras located as shown in Figure 2. The instrument, shown in Figure 3, is an optical tracker having a movie camera triggered electronically at the rate of two frames per second. The film field of view includes the target and azimuth and elevation dials. The location of the theodolites perpendicular to the runway requires the assumption that the aircraft is flying down the centerline.

Both the radar and phototheodolite data were reduced to yield the appropriate coordinate values. In this report, X coordinate is crossrange, Y coordinate is downrange, and Z coordinate is height above the reference point. The reference point was chosen as the intersection of the runway centerline and a line passing through the microphone positions.

Tracking data output consisted of both hard copy and digital tapes.

TEST AREA

Tests were conducted in the vicinity of the Pendleton Municipal Airport, Pendleton, Oregon, during the months of July and October 1970. Acoustic data was acquired during the July tests at the four sites shown in Figure 4. Two microphones are located at each site, one at ground level and the other at a height of 26 feet directly above the ground microphone. The odd-numbered microphone is at ground level and the even-numbered microphone is 26 feet

Figure 1. Radar Tracking Unit

in the air. The eight sites used during the October 1970 tests are shown in Figure 5. These microphones were located at a height of four feet above the ground. During both tests, the ground surface was fallow except site 1 in Figure 4 and sites 1 and 2 in Figure 5. The ground surface here consisted of a thin layer of soil over rock.

NOISE MEASUREMENTS

The noise measuring instrumentation used in these tests is illustrated in the block diagram in Figure 6. The condenser microphones were fitted with windscreens and positioned with the diaphragm parallel to the ground. Therefore, the angle of incidence varied according to the test altitude and microphone position, as shown in Figure 7. The microphone output was recorded on a 14-channel FM tape recorder. Time correlation between all operational units was achieved through the use of an IRIG B time code, synchronized to WWV. The field calibrations included recording an electrical tone at each of the one-third octave band center frequencies and the periodic recording of a 94-dB acoustic signal at 1000 cps. During these tests, preemphasis of the high frequencies was used.

Table II. October Test Flights

Aircraft With Afterburner

Run No.	Altitude Above MSL.* (ft)	Thrust (%)
1	7500	100
2	2500	Afterburner
3	2500	100
4	2500	75
5	1700	100
6	1700	75
7	1700	50

*Runway Elevation - 1500 ft MSL.

Aircraft Without Afterburner

Run No.	Altitude Above MSL.* (ft)	Thrust (%)
1	7500	100
2	7500	75
3	2500	100
4	2500	75
5	1700	100
6	1700	75
7	1700	50

*Runway Elevation - 1500 ft MSL.

DATA REDUCTION AND ANALYSIS

Data reduction consisted of on-line processing of a selected microphone during the test and off-line processing at San Diego. The on-line processing was performed by the system described in Reference 1. The San Diego in-house system is shown in Figure 8. The total system response was determined by processing the calibration tapes. A typical system response is shown in Figure 9. An angle of incidence correction was applied to each site.

The system hardware and software conform to the requirements of FAR Part 36, Reference 2. The reduction of acoustic data conformed to the requirements of Reference 2, with one exception. This exception relates to the correction of acoustic data to a standard day temperature of 77° F and 70-percent relative humidity.

Table III. July Test Flights

Run No.	Altitude Above MSL.* (ft)	Thrust (%)
1	3500**	100
2	3500**	100
3	3000	100
4	3000	100
5	2200	100
6	2200	100
7	1600	100
8	1600	100

* Runway Elevation - 1500 ft MSL.
**T-33 Only

During initial processing of data, it was noticed that some test day EPNL values, when corrected to standard day, were yielding unrealistic answers. Further investigation indicated that these problems of over correction occurred when the measured aircraft noise level spectrum was being limited by the background and/or system noise level. This background noise can be defined as one or a combination of: 1) environmental ambient noise, 2) data acquisition system noise, and 3) data processing system noise.

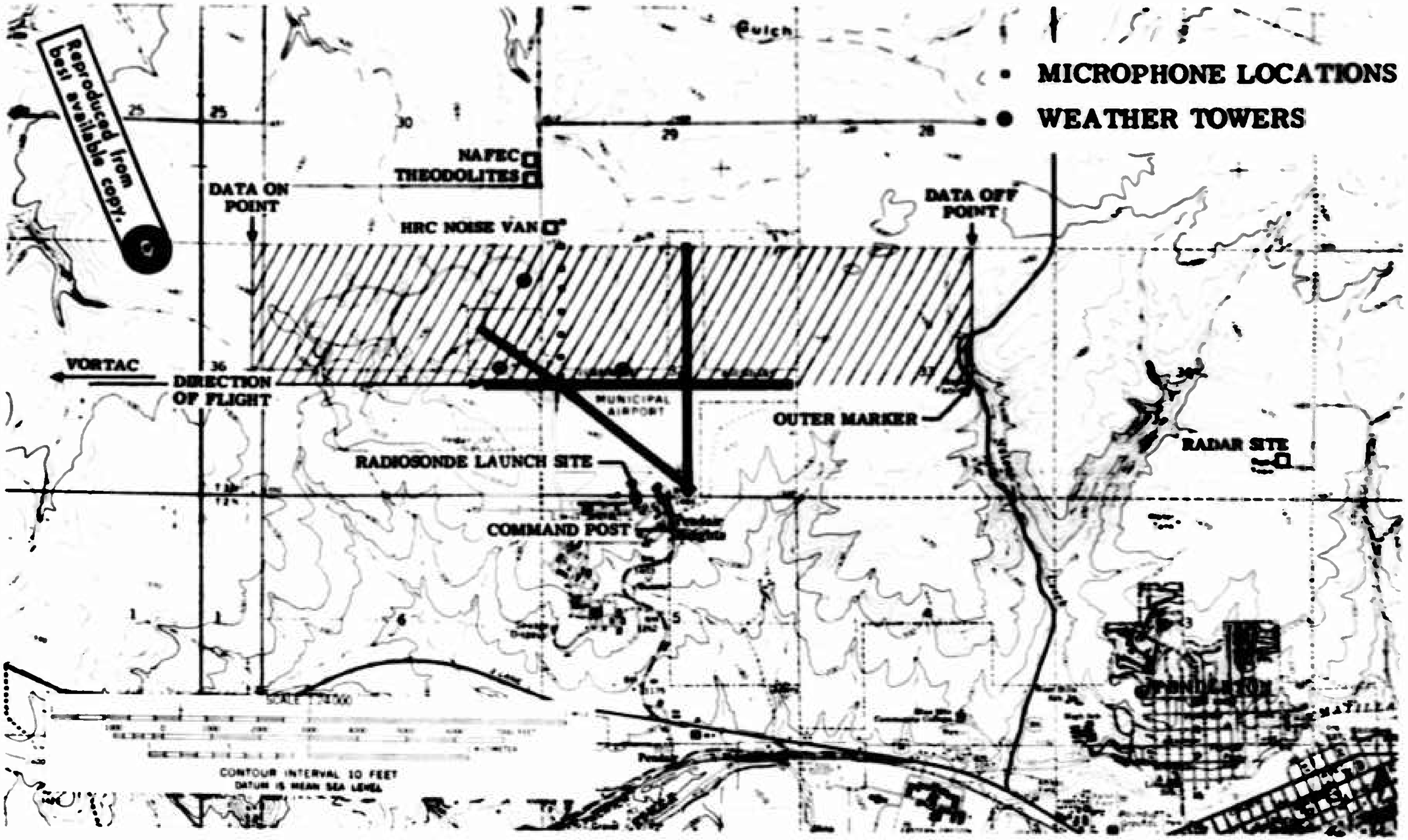


Figure 2. Test Site

Figure 3. Phototheodolite Unit

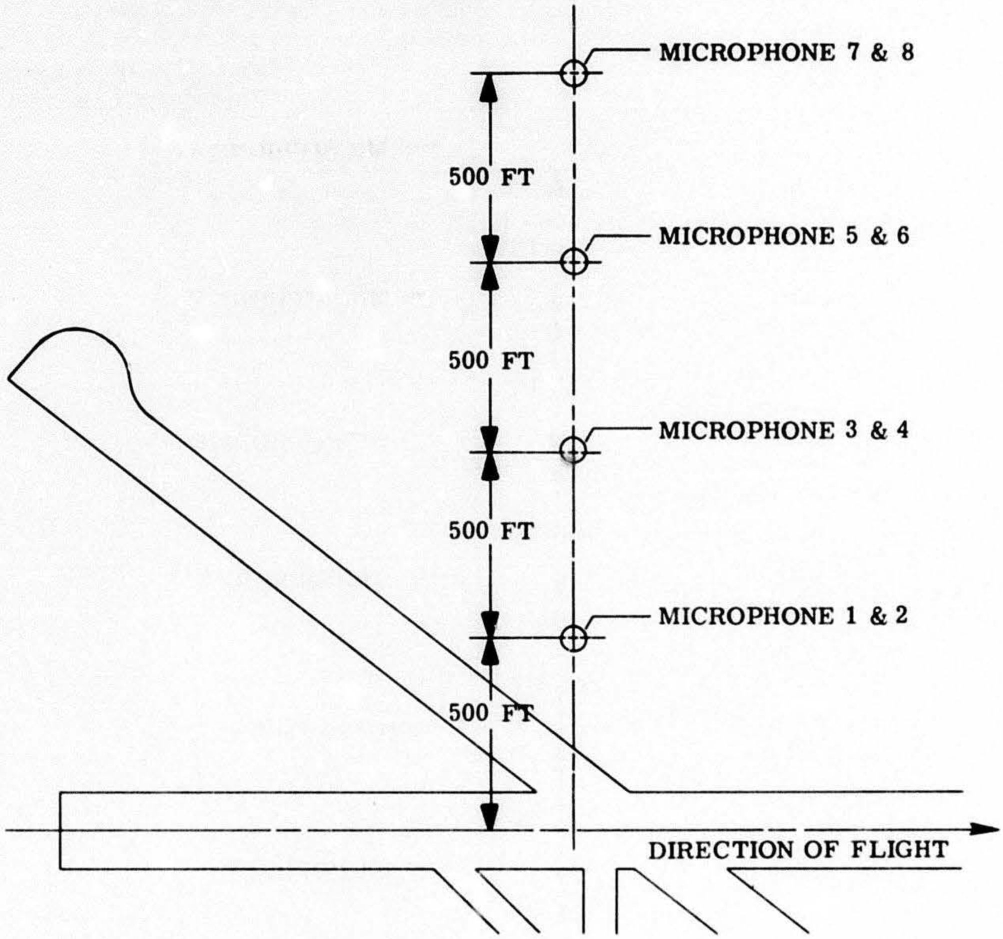
Since a large portion of the data was acquired at slant range distances in excess of those encountered in a noise certification test for which Part 36 is designed, an alternate method of applying the atmospheric absorption corrections was necessary in order that the results would be meaningful. The method chosen consists of comparing the spectrum at the time of maximum tone-corrected perceived noise level (PNLTM) with the last spectrum acquired in the processing routine. The last spectrum was selected because of its availability at the end of the sound pressure level acquisition routine, and except for low frequencies, is a good measure of the background noise. When the difference between the spectrum at PNLTM and the background, at frequencies greater than 400 cps, is equal to or less than 3 decibels, the atmospheric absorption correction consists of the alpha value used for the last band having a signal-to-noise ratio greater than 3 decibels. The comparison of the first ten bands is ignored because the last spectrum may consist of low frequencies attributable to the aircraft.

It is recognized that this is a conservative method in that atmospheric absorption corrections are being made to spectrum levels not associated with the aircraft.

Other methods of solution to this particular problem are discussed in detail in Reference 3.

ATMOSPHERIC OBSERVATIONS

The meteorological parameters acquired during the October tests are summarized in Table IV. Three types of weather observations were made: 1) surface, 2) radiosonde, and 3) aircraft soundings.



NOTE: ODD NUMBERED MICROPHONES LOCATED NEAR GROUND LEVEL.

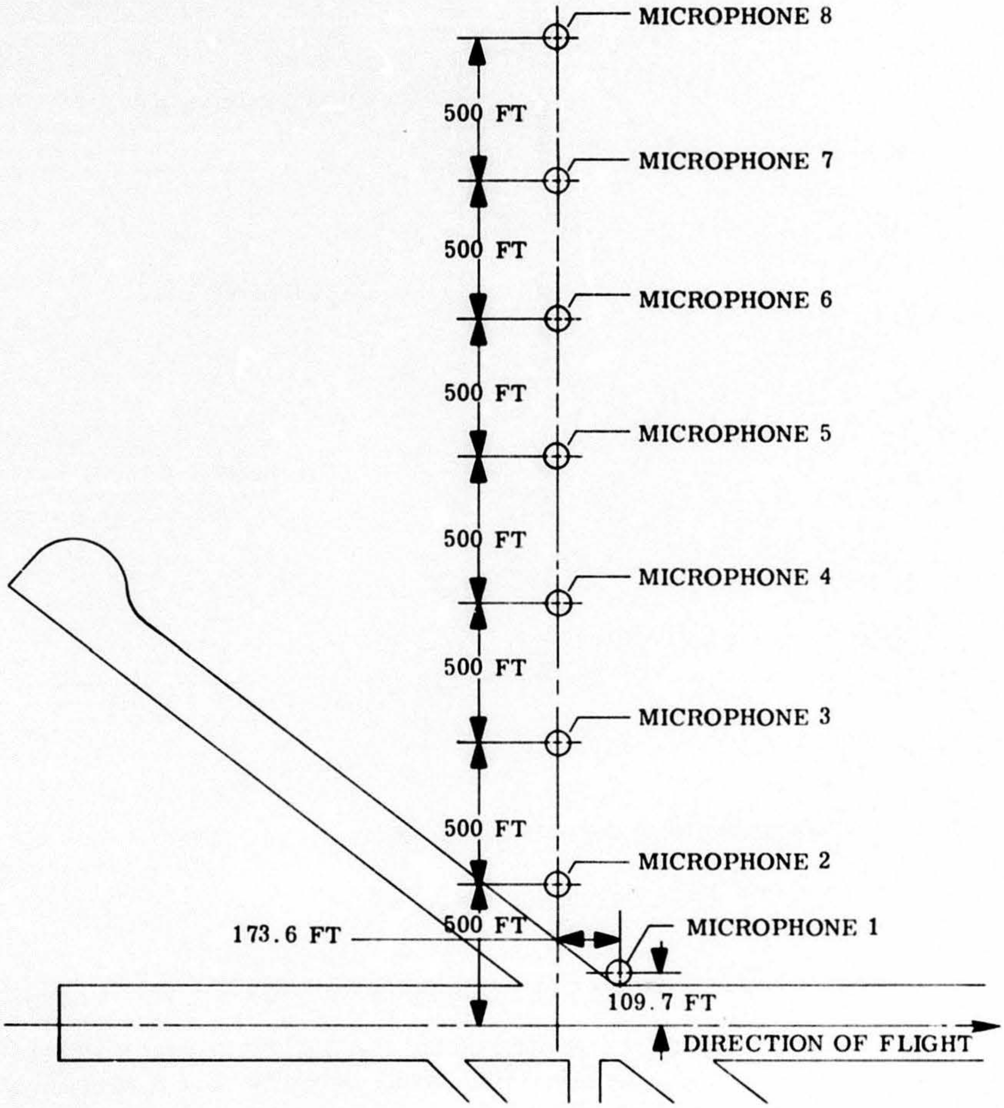
EVEN NUMBERED MICROPHONES LOCATED 26 FEET ABOVE THE GROUND.

Figure 4. Location of Microphones for July Tests

The surface observations consisted of data acquired at three towers located as shown in Figure 2. In addition, wind velocity and direction were acquired at each microphone location.

Data was continuously recorded on strip charts at the towers during the entire test period. Data was extracted from these charts at the time of day associated with the closest point of approach of the aircraft to the line of microphones. The data was averaged over 2 minutes.

Radiosonde balloons were launched periodically during the test day. In general, these soundings provided data representative of each particular test



NOTE: ALL MICROPHONES LOCATED FOUR FEET ABOVE THE GROUND.

Figure 5. Location of Microphones for October Tests

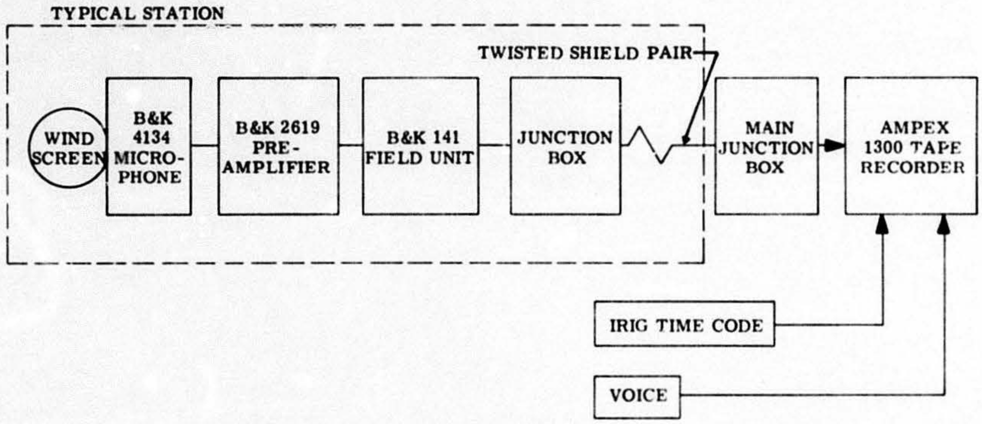


Figure 6. Noise Acquisition System

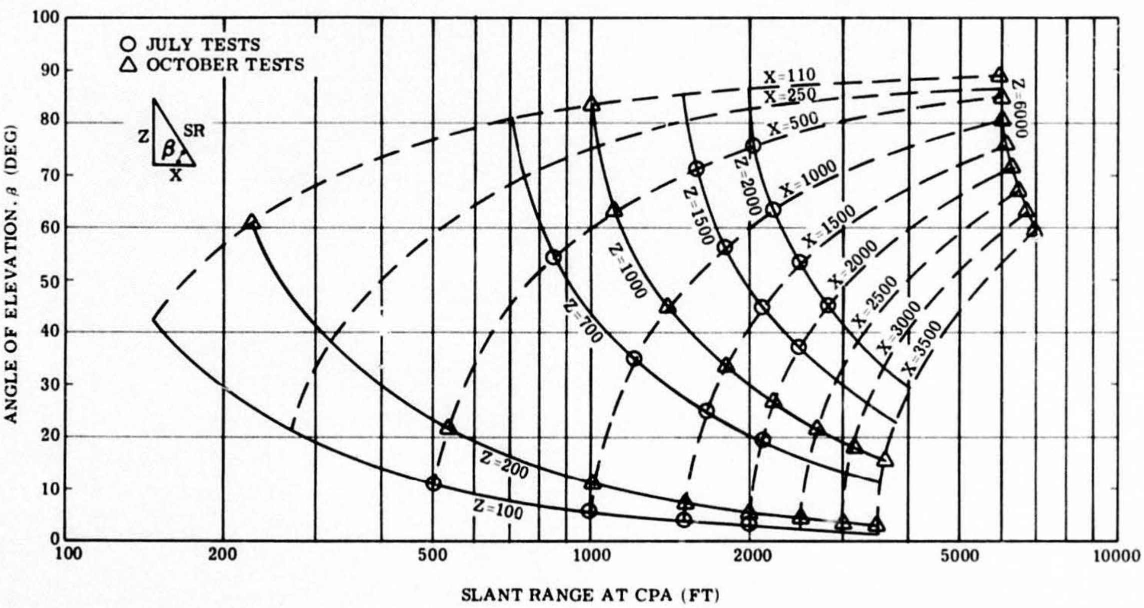


Figure 7. Slant Distance as a Function of Base, Height, and Elevation Angle

Figure 8. HRC In-House Facilities, Model 1360

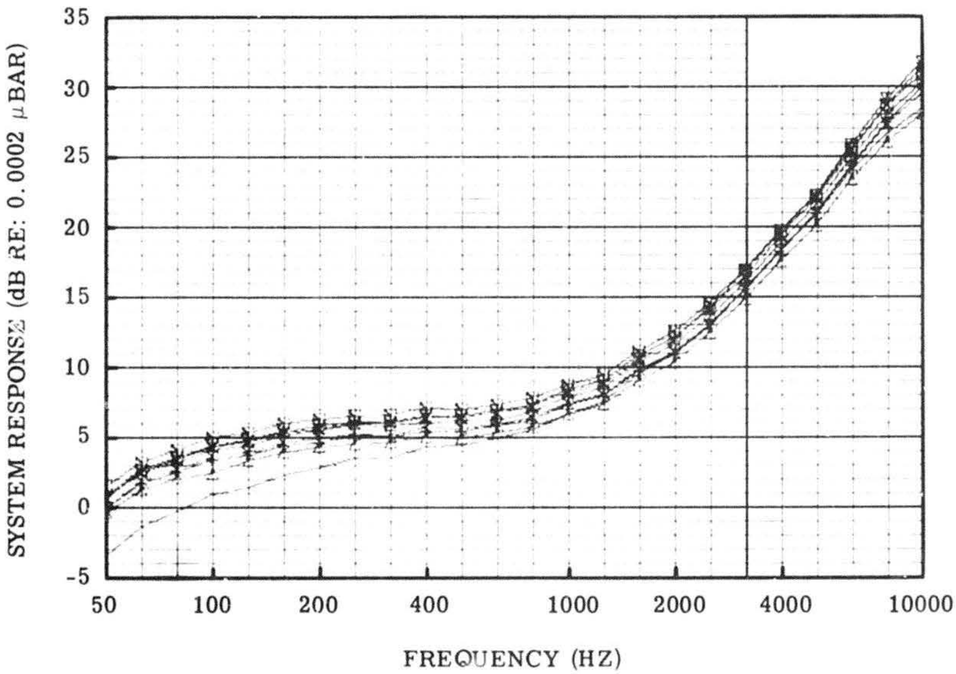


Figure 9. System Frequency Response

Table IV. Meteorological Parameters - October Tests

Type	Temperature	Relative Humidity	Wind Velocity	Wind Direction	Elevation (ft)	Frequency of Measurement
Aircraft	X	X			50 - 2500	Before every run
Radiosonde	X	X	X	X	0 - 3000	Bi-hourly
Surface	X	X	X	X	6	Continuously
Surface	X	X	X		50	Continuously
Surface	X	X	X		50	Continuously
Surface	X	X	X		50	Continuously
Surface	X	X	X	X	100	Continuously
Surface			X	X	26	Every run
Surface	X	X	X	X	10	Hourly

period. The balloon was launched to the south of the test site at the location shown in Figure 2. The balloon transponder was tracked via a radar. The radiosonde yielded temperature and dew point, averaged over 6-second intervals. Winds aloft were calculated from changes in balloon position, from one tracking point to the next.

Upper air soundings were also made using the aircraft shown in Figure 10. This aircraft flew a sounding profile shown in Figure 11. Meteorological instrumentation included a Cambridge Systems Model 137-C/137-S3P hygrometer.

The results of the aircraft soundings are shown in a series of graphs in Figures 12 through 15. The atmospheric absorption corrections for October data were calculated from ARP 866, Reference 4, using the temperature and relative humidity data from the central tower at the 50-foot elevation.

Figure 10. Weather Aircraft

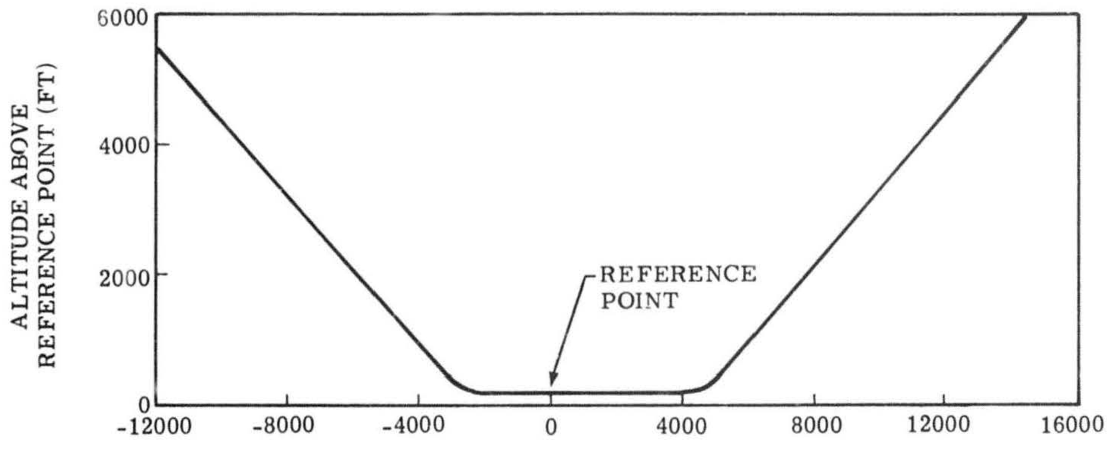
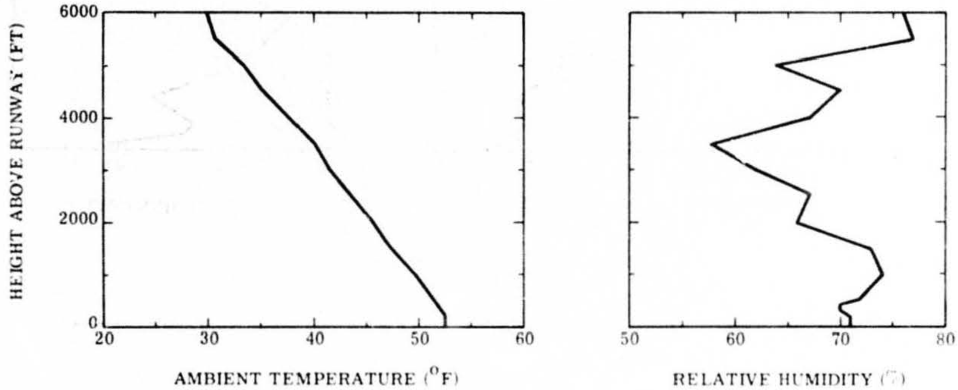
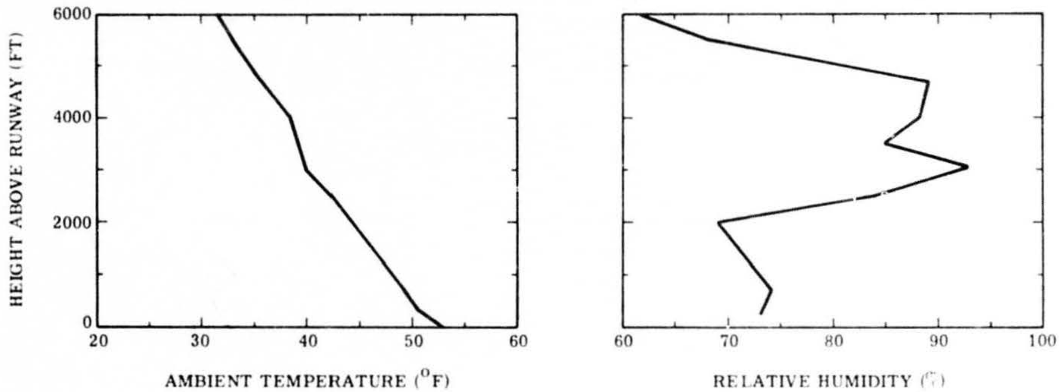


Figure 11. Sounding Profile

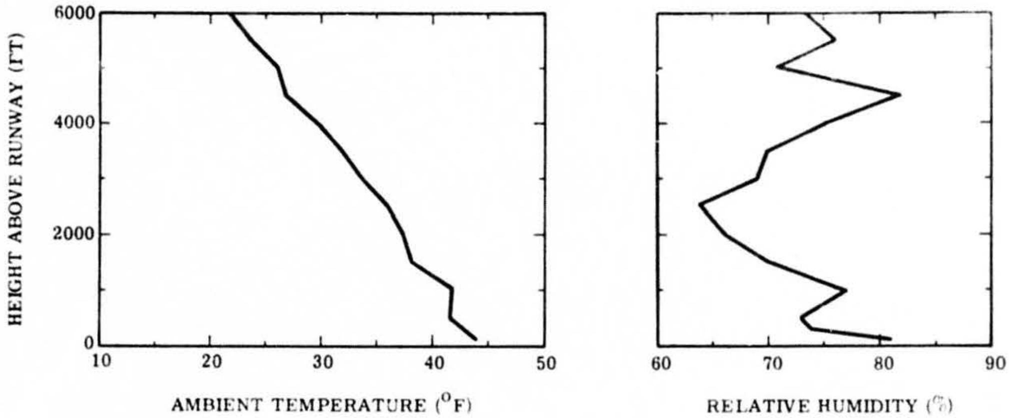


a. A-6A Tests

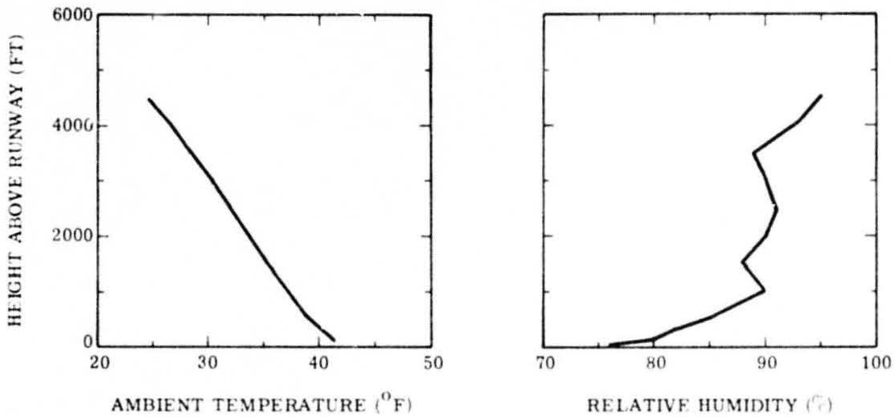


b. F-8K Tests

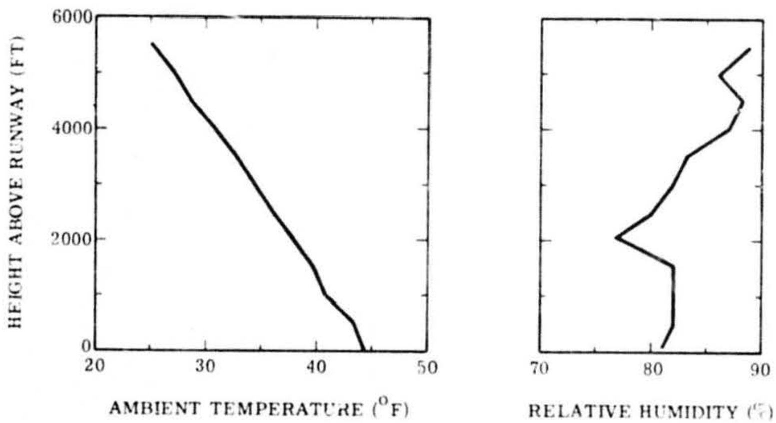
Figure 12. Aircraft Sounding (5 October 1970)



a. F-4 Tests

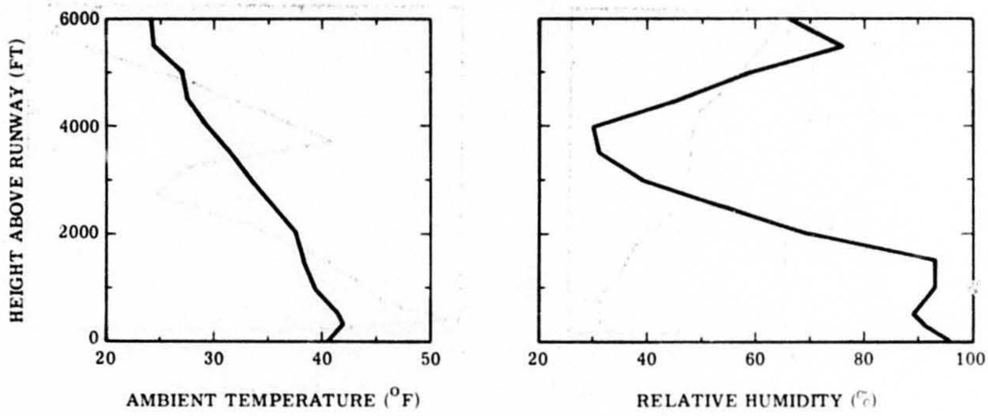


b. F-102 Tests

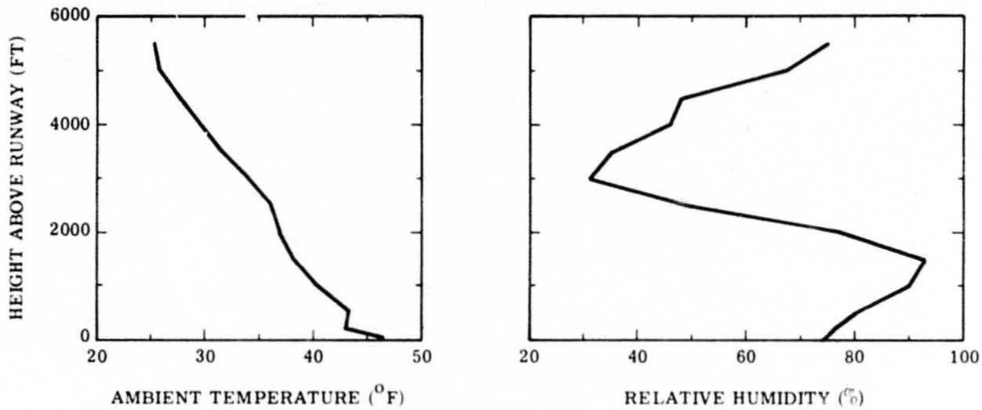


c. C-141A Tests

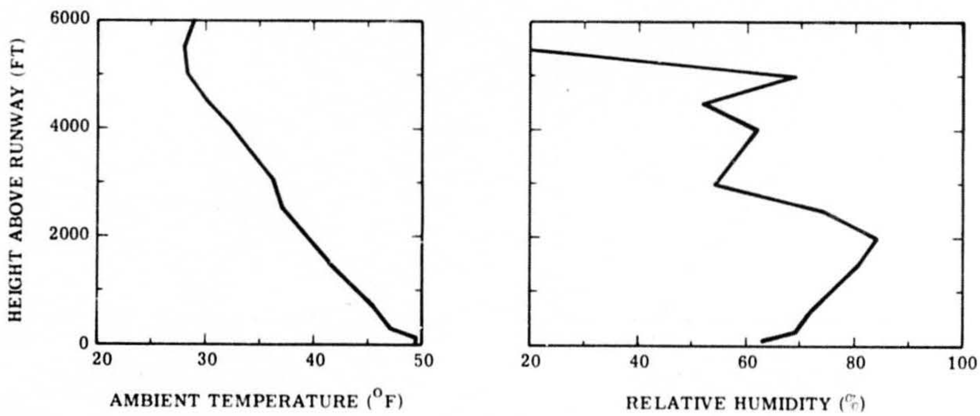
Figure 13. Aircraft Sounding (6 October 1970)



a. DC-9 Tests

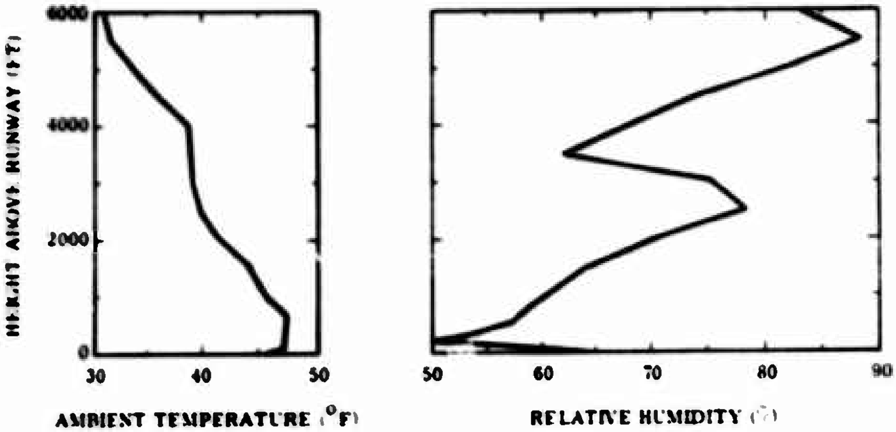


b. F-101 and A-7B Tests

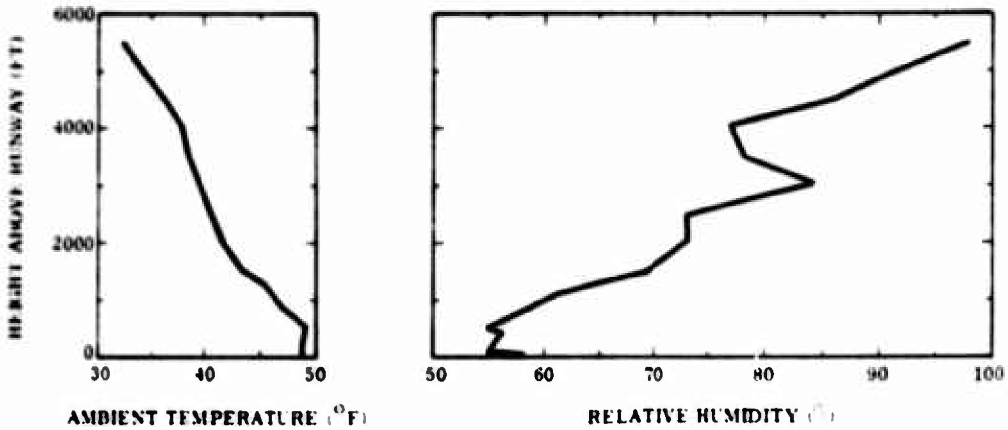


c. A-4C Tests

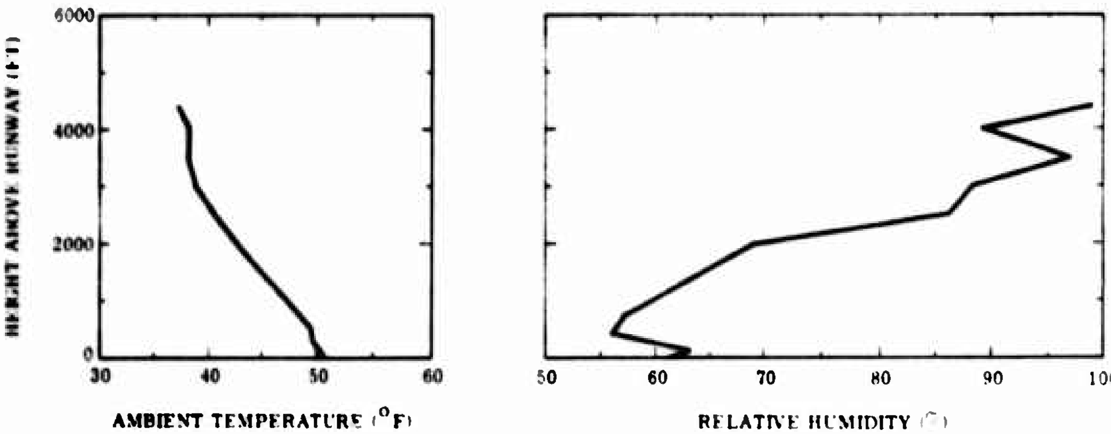
Figure 14. Aircraft Sounding (7 October 1970)



a. Learjet-23 Tests



b. Jet Commander Tests



c. Sabreliner Tests

Figure 15. Aircraft Sounding (8 October 1970)

DISCUSSION OF RESULTS

AIRCRAFT PERFORMANCE

The performance of the aircraft during the flyby operations is indicated by the tabulated results in Tables V and VI for the October tests. These values were obtained from the pilot test cards. No data was available from the July test of general aviation aircraft.

The altitude profile and lateral deviation track of the test aircraft over the runway was an average of ±200 feet, based on an examination of the radar analog plots.

ATMOSPHERIC OBSERVATIONS

Summaries of the October prevailing meteorological conditions are given in Figures 12 to 15 for the aircraft tested. This data indicates an erratic and large variation in relative humidity as a function of altitude. This is due to the unstable air mass moving through the area during the test period. Precipitation was present during this time period.

The July prevailing meteorological conditions for the general aviation aircraft are shown in Table VII. Aircraft soundings and radiosonde data were not available for this date. Atmospheric absorption corrections were based on the surface measurements provided by the airport weather bureau.

NOISE MEASUREMENTS

The results of the flyby noise measurements obtained during the July tests for the general aviation aircraft are presented in Figures 16 to 19. Figure 16 shows a comparison of the noise levels as measured by the microphone at 26 feet above the ground and by the ground microphone. Due to the large variation between these data, only those data measured by the microphone located 26 feet above the ground are presented in Figures 17, 18, and 19.

Data for the business jet aircraft is presented in Figures 20 to 23. The results for the military aircraft are given in Figures 24 to 51.

The data is presented in subsets for $\beta > 15$ degrees and $\beta < 15$ degrees, where possible, for each range of power settings. Each subset is composed of data at specific flyby altitudes and microphone locations. The flyby altitudes given on the figures are the heights above the reference point. In addition, the surface weather conditions are given on each figure. Note that the wind speeds were in excess of 10 knots for a large portion of the data.

Table V. Aircraft Flight Performance, Military Aircraft

Aircraft	MSL*** Altitude (ft)	Aircraft Weight (lb)	OAT* (°C)	Power (%)	IAS** (kt)	Date of Test
A-6A	7500	42,000	+10	100	440	5 October 1970
	7300	41,500	+5	75	190	
	2500	40,700	+25	100	475	
	2500	40,100	+15	75	230	
	2500	38,600	+15	89	135	
	1700	37,600	+37	100	510	
	1700	37,200	+20	75	240	
	1700	36,700	+15	89	130	
	1700	35,600	+15	98	220	
F-8K	7500	25,000	-	97	170	5 October 1970
	2500	24,500	-	A/B	170	
	2500	24,000	-	97	170	
	2500	23,500	-	93	140	
	1700	23,000	-	96	150	
F-4	7500	44,000	+4	100	480	6 October 1970
	7500	43,000	+4	85	180	
	2500	42,000	+4	A/B	560	
	2500	41,000	+4	100	540	
	2500	40,000	+4	85	180	
	1700	39,000	+4	100	550	
	1700	38,000	+4	85	180	
F-102	6500	29,500	-1	100	280	6 October 1970
	2500	28,000	+3	100	240	
	2500	27,000	+3	100	210	
	2500	26,400	+3	55	170	
	1700	25,300	+4	100	210	
	1700	24,600	+4	55	170	
C-141A	7500	168,000	+0	82/90	170	6 October 1970
	7500	163,000	+0	75/88	180	
	2500	161,000	+9	83/91	180	

* OAT = Outside Air Temperature
** IAS = Indicated Airspeed
***MSL = Mean Sea Level

Table V. Aircraft Flight Performance, Military Aircraft, Contd

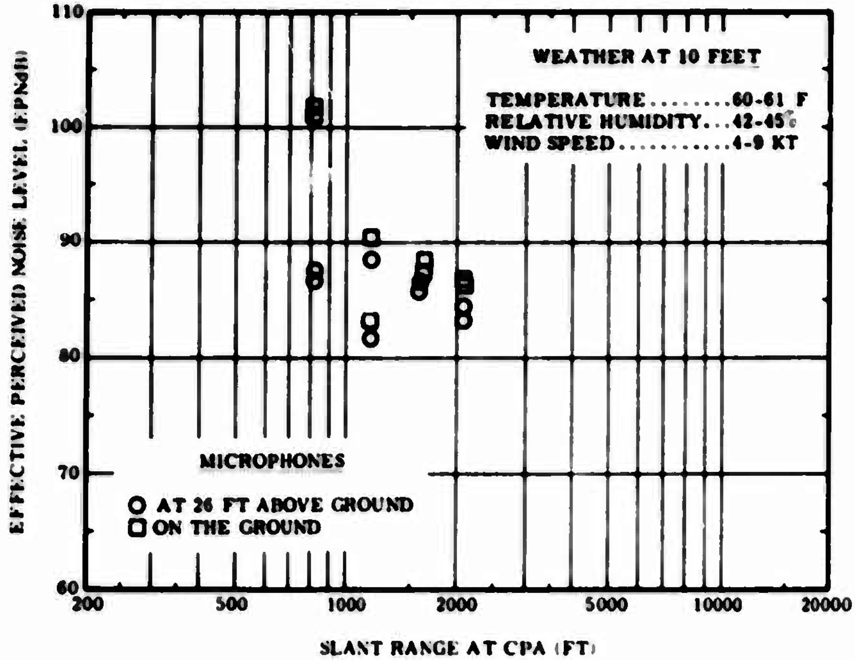
Aircraft	MSL*** Altitude (ft)	Aircraft Weight (lb)	OAT (°C)	Power (%)	IAS (kt)	Date of Test
F-101	7500	46,000	-1	100	420	7 October 1970
	2500	48,000	+4	100	420	
	2500	44,000	+4	87	220	
	1700	43,000	+8	100	430	
	1700	42,000	+8	86	210	
A-7B	7500	24,500	+7	100	220	7 October 1970
	7500	24,250	+7	88	165	
	2500	23,900	+7	100	220	
	2500	23,550	+7	88	165	
	2500	23,200	+7	85	135	
	1700	22,850	+7	100	200	
	1700	22,500	+7	86	160	
	1700	22,150	+7	84	128	
A-4C	7500	16,000	+7	100	450	
	7500	15,800	+7	75	330	
	2500	15,000	+7	100	480	
	2500	14,800	+7	75	320	
	2500	14,400	+7	75	120	
	1700	14,200	+7	100	380	
	1700	14,000	+7	75	450	
	1700	13,800	+7	75	140	
	2500	13,600	+7	75	500	
T-33	3500	14,000	No Data	100	155	14 July 1970
	3500	13,500			153	
	3000	13,000			160	
	3000	12,500			159	
	2200	12,000			163	
	2200	11,500			181	
	1600	11,000			168	
	1600	10,500			169	

Table VI. Aircraft Flight Performance, Business Jet Aircraft

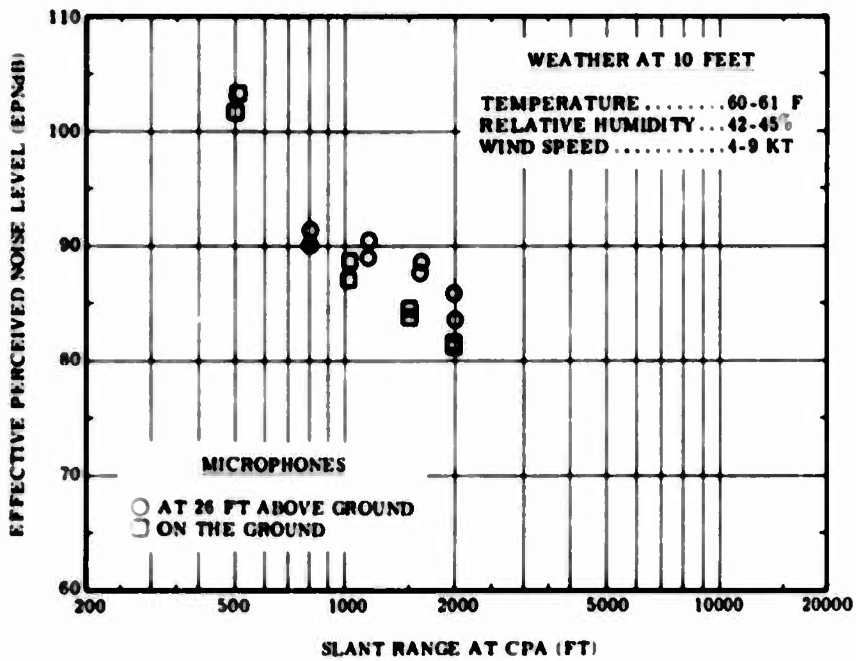
Aircraft	MSL Altitude (ft)	Aircraft Weight (lb)	OAT (°C)	Power (%)	IAS (kt)	Date of Test
DC-9	7500	77,250	-	100	200-350	7 October 1970
	7500	76,350	-	75	220-350	
	2500	75,340	-	100	240-350	
	2500	74,250	-	75	160-330	
	2500	73,200	-	75	127-130	
	1700	72,100	-	100	170-350	
	1700	71,350	-	75	172-320	
	1700	70,350	-	75	138-128	
Learjet-25	7500	12,300	+9	100	250	8 October 1970
	7500	11,900	+7	88	118	
	2500	11,500	+19	100	260	
	2500	10,900	+14	85	140	
	2500	10,500	+14	78	105	
	1700	10,100	+17	100	230	
	1700	9,700	+15	84	100	
Jet Commander-1121A	6800	15,800	-1	96.5	180	8 October 1970
	6900	15,400	+0	92.5	140	
	2500	14,900	+6	95.0	180	
	2500	14,600	+7	92.5	154	
	2500	14,100	+8	87.5	115	
	1700	13,600	+8	94.0	180	
	1700	13,000	+9	92.5	166	
	1700	15,000	+11	88.5	120	
Sabreliner - 60	6000	17,000	+7	90	180	8 October 1970
	6000	16,600	+7	82	174	
	2500	16,100	+10	90	180	
	2500	15,900	+10	82	174	
	2500	15,500	+10	70	128	
	1700	15,100	+13	90	180	
	1700	14,900	+13	80	155	
	1700	14,500	+13	75	120	

Table VII. July Meteorological Conditions, General Aviation Aircraft Tests

Aircraft	Run Number	Ambient Temperature (°F)	Relative Humidity (%)
Cherokee 6	1	60.0	45
	2	60.5	42
	3	61.0	43
	4	60.0	44
	5	60.5	43
	6	60.5	43
	7	61.0	44
Cessna 210	8	60.5	45
	9	62.0	42
	10	60.5	45
	11	61.0	43
	12	62.5	43
	13	63.5	40
	14	63.5	40
	15	64.0	40
Cessna 182	16	72.0	29
	17	72.5	31
	18	72.5	30
	19	73.0	29
	20	-	-
	21	73.5	28
	22	72.5	28
Cessna 337	23	75.5	28
	24	76.5	27
	25	78.5	27
	26	-	-
	27	77.0	27
	28	78.0	28

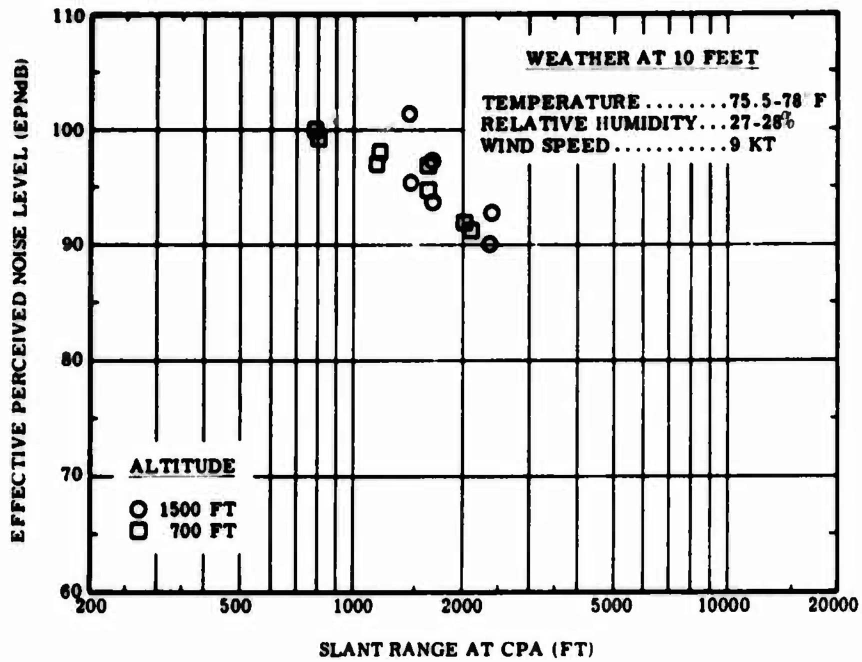


a. $\beta > 15°$; Z = 700 Feet

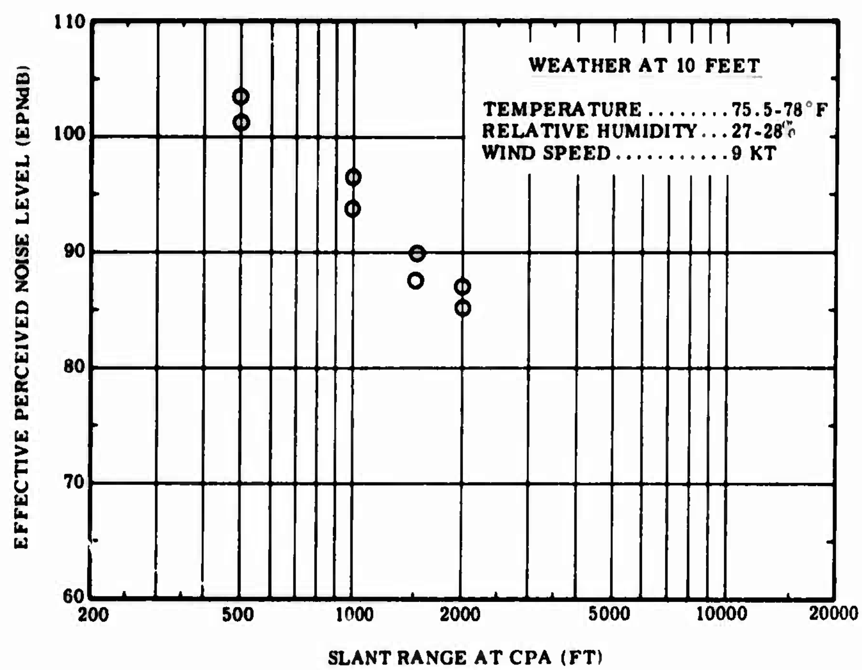


b. $\beta < 15°$; Z = 100 Feet

Figure 16. Noise Level of Cherokee 6, 100-Percent Power

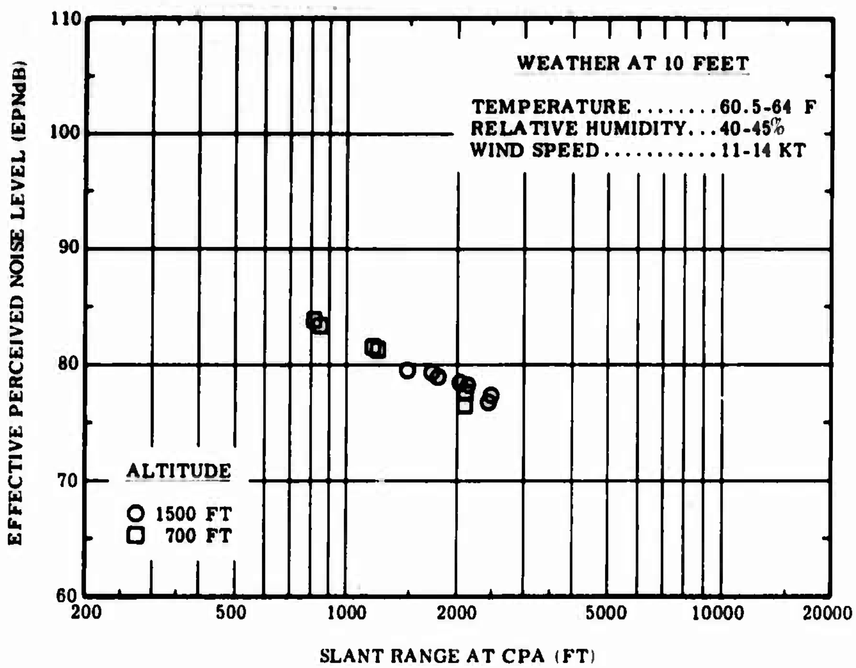


a. $\beta > 15°$; Z = 1500 and 700 Feet

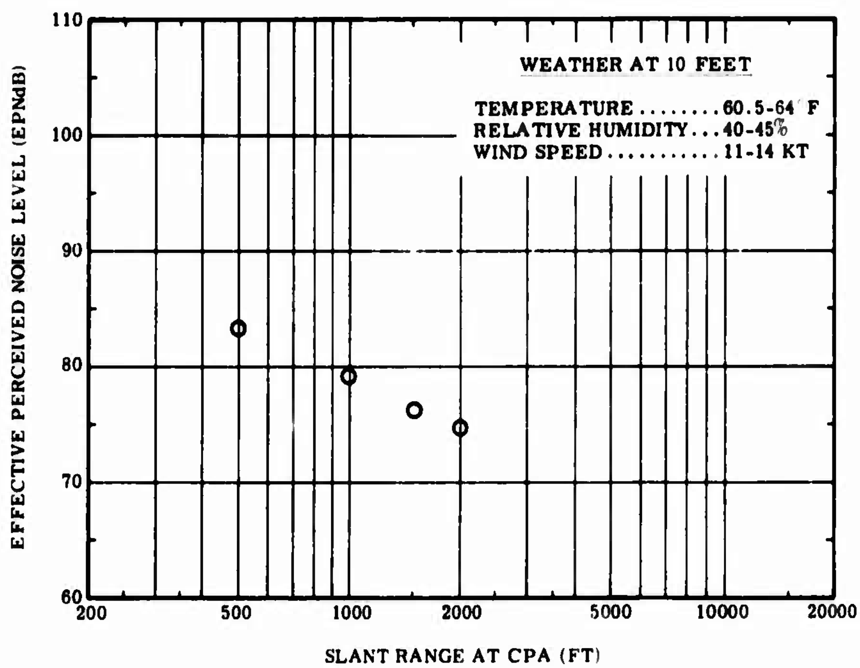


b. $\beta < 15°$; Z = 100 Feet

Figure 17. Noise Level of Cessna 337, 100-Percent Power

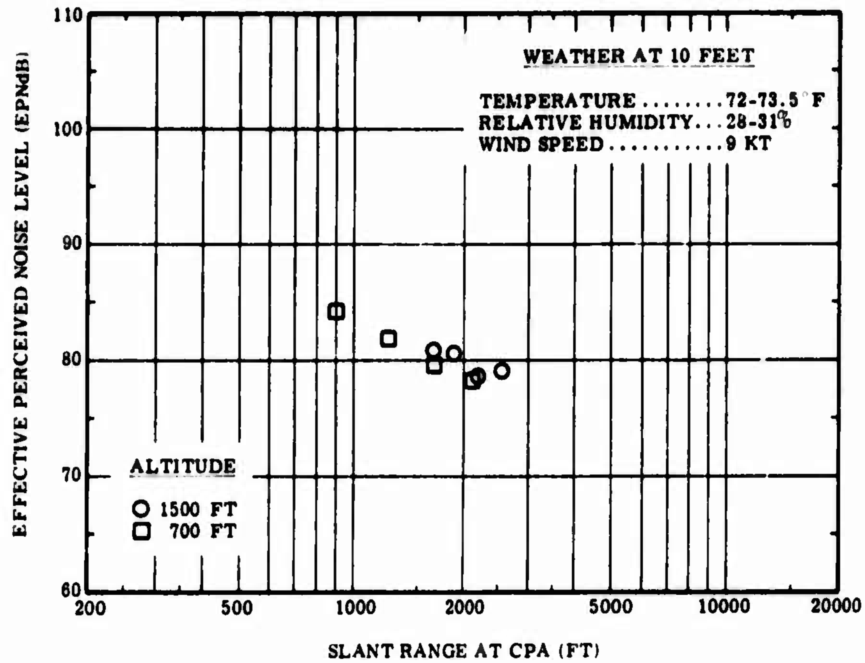


a. $\beta > 15^\circ$; Z = 1500 and 700 Feet

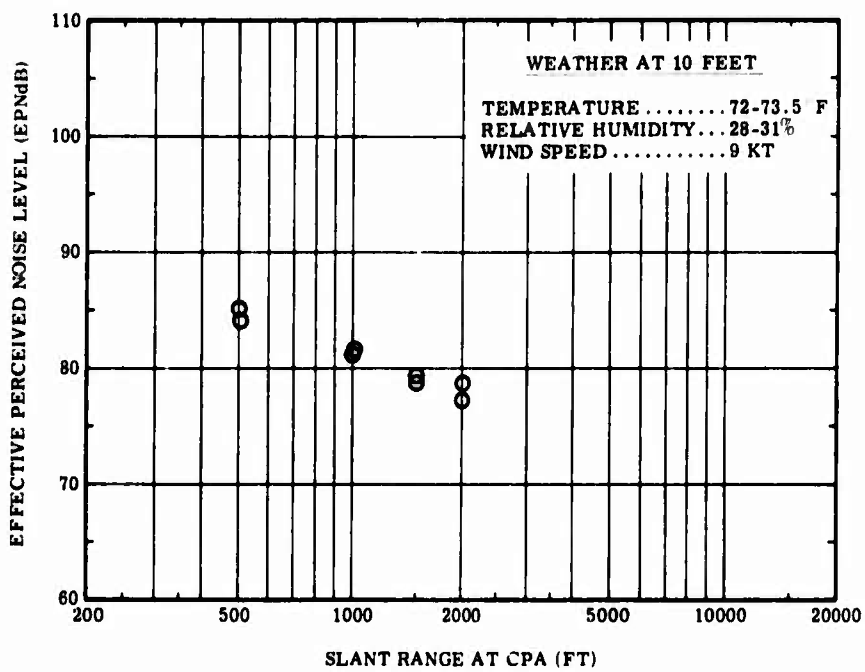


b. $\beta < 15^\circ$; Z = 100 Feet

Figure 18. Noise Level of Cessna 210, 100-Percent Power

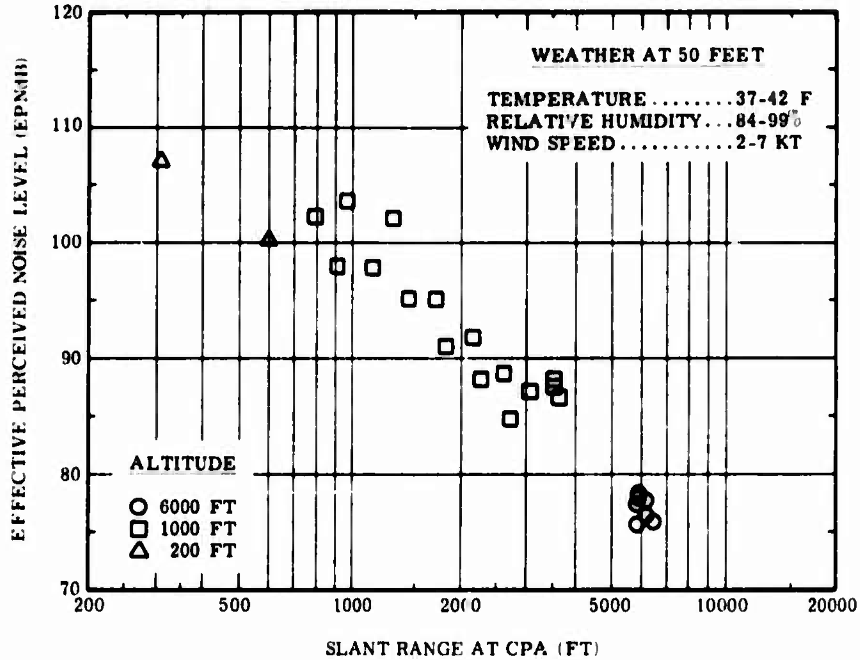


a. $\beta > 15°$; Z = 1500 and 700 Feet

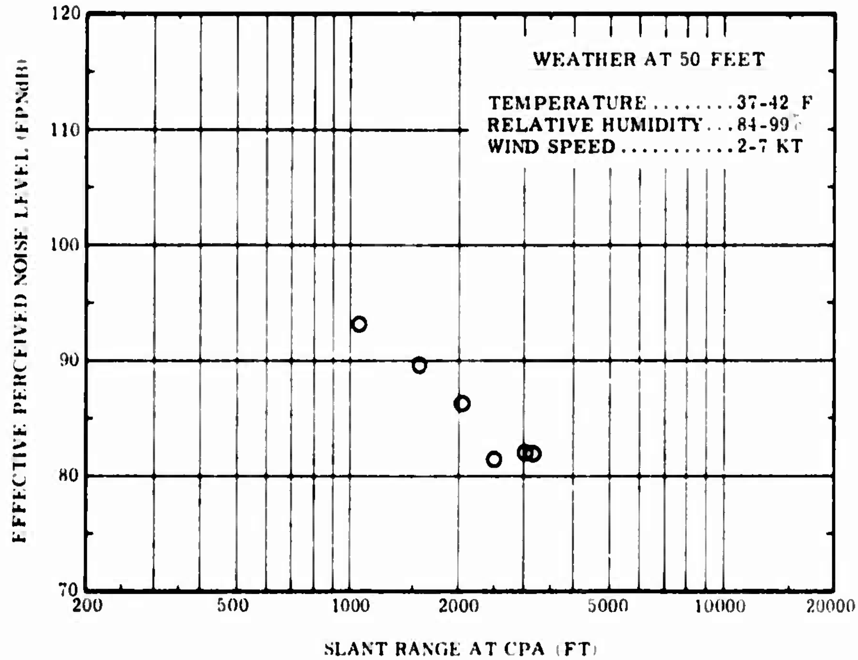


b. $\beta < 15°$; Z = 100 Feet

Figure 19. Noise Level of Cessna 182, 100-Percent Power

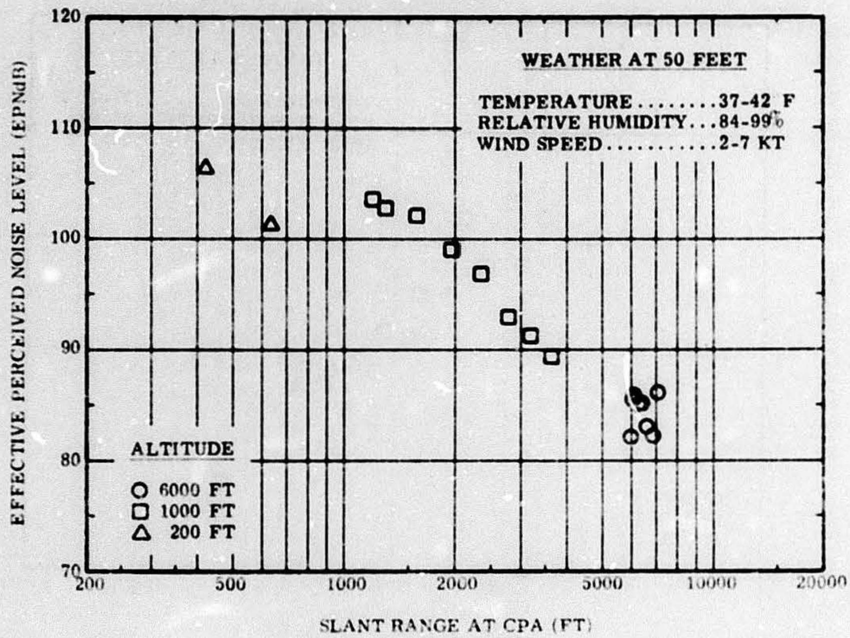


a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet

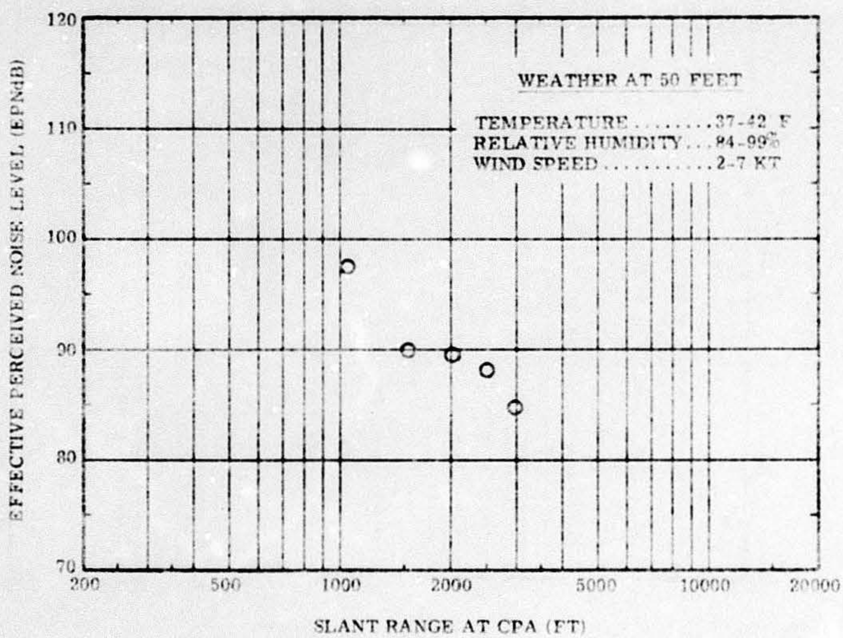


b. $\beta < 15°$; Z = 200 Feet

Figure 20. Noise Level of DC-9, 75-Percent Power

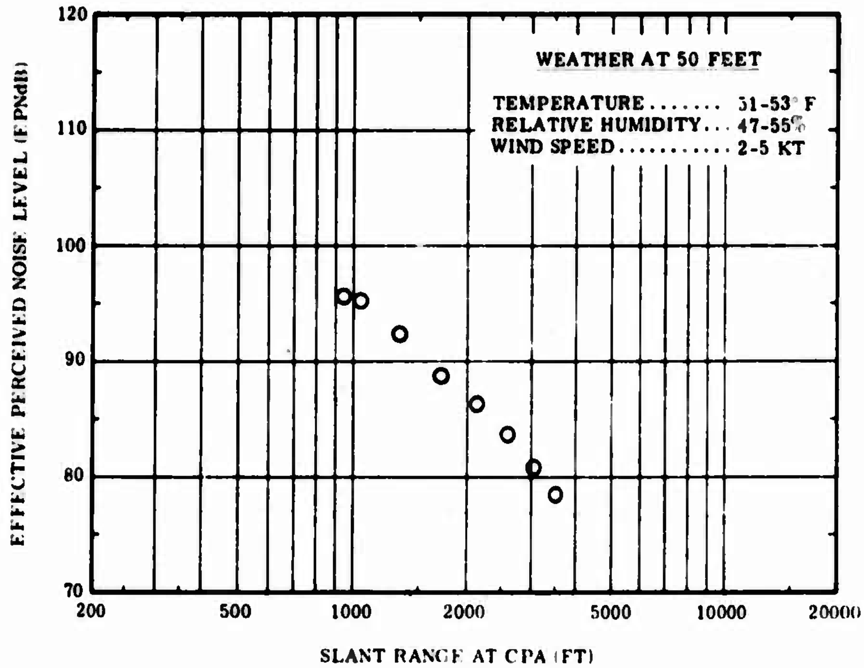


a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet



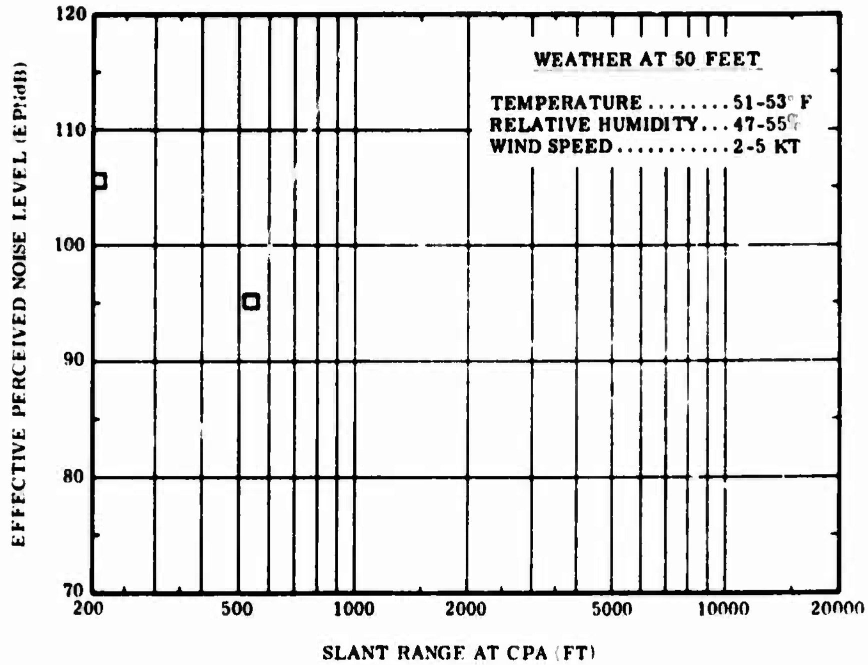
b. $\beta < 15°$; Z = 200 Feet

Figure 21. Noise Level of DC-9, 100-Percent Power

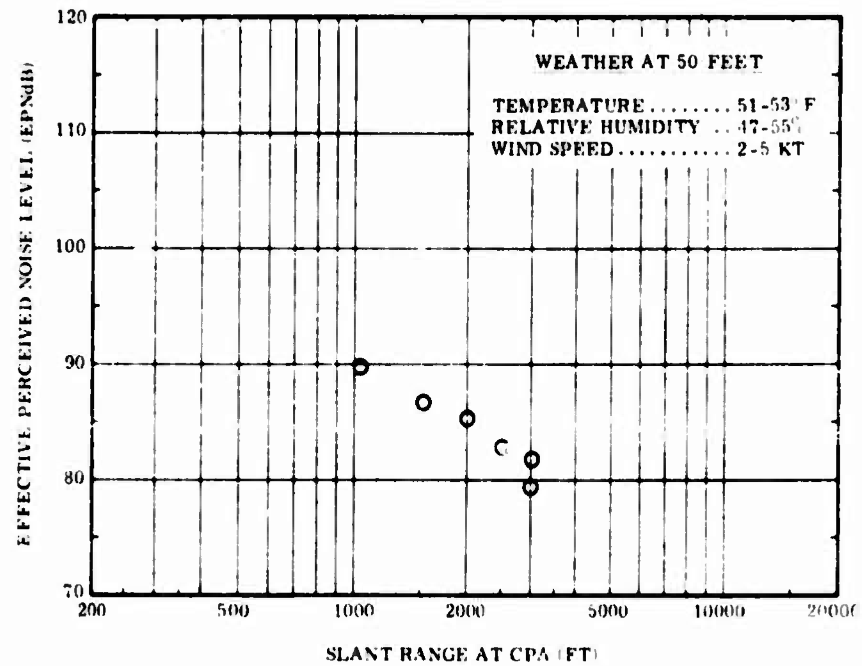


$\beta > 15°$; Z = 1000 Feet

Figure 22. Noise Level of Sabreliner, 70-Percent Power

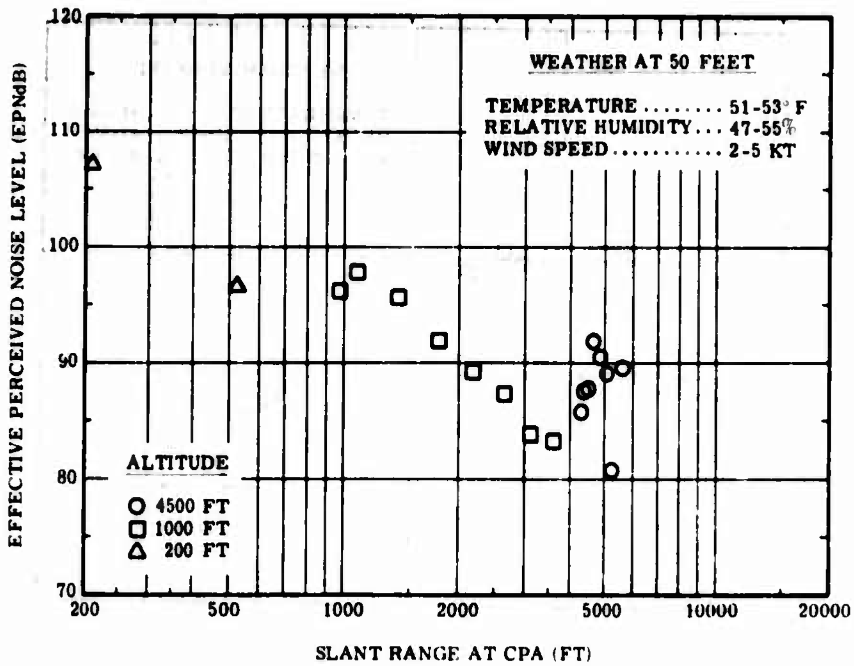


a. $\beta > 15°$, Z = 200 Feet

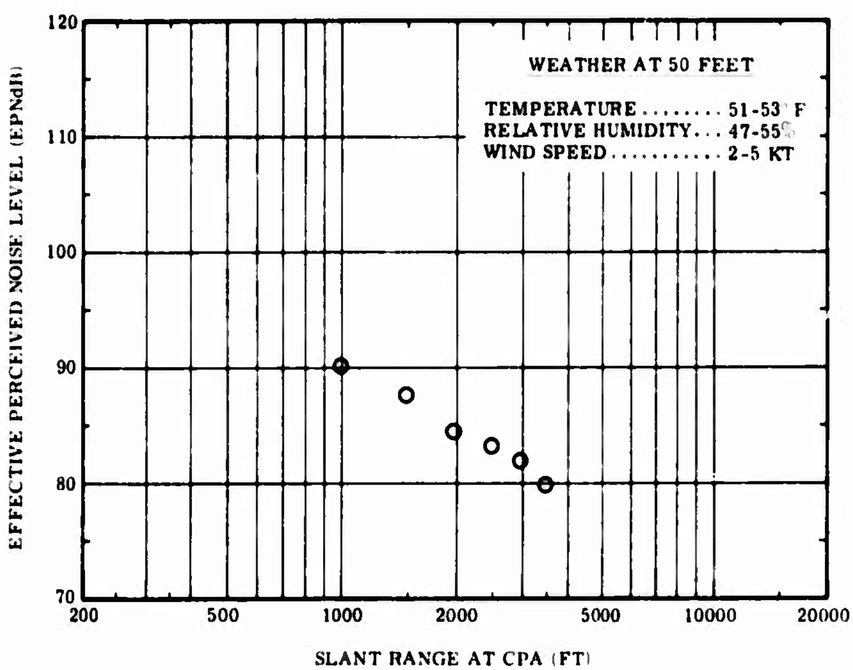


b. $\beta < 15°$, Z = 200 Feet

Figure 23. Noise Level of Sabreliner, 75-Percent Power

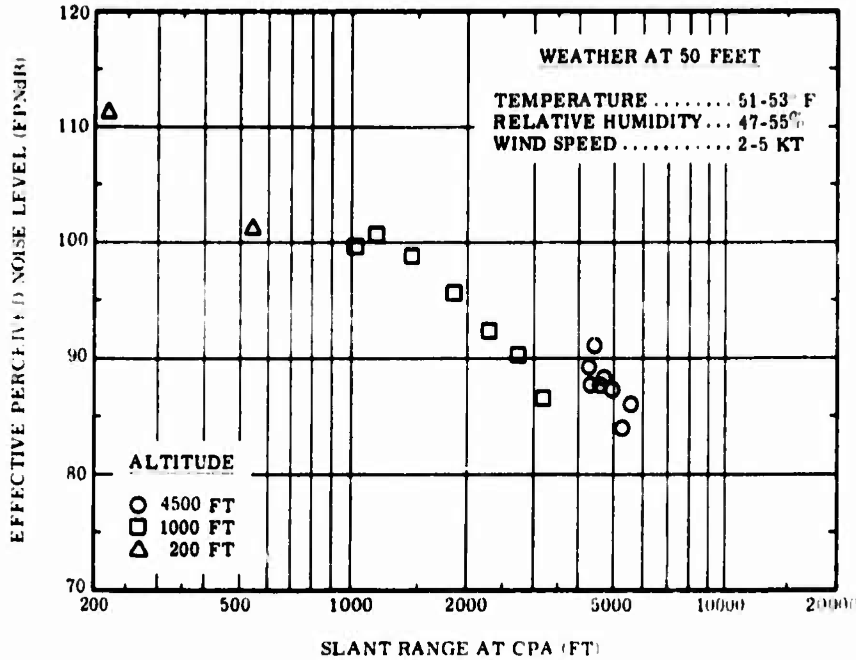


a. $\beta > 15°$; Z = 4500, 1000, and 200 Feet

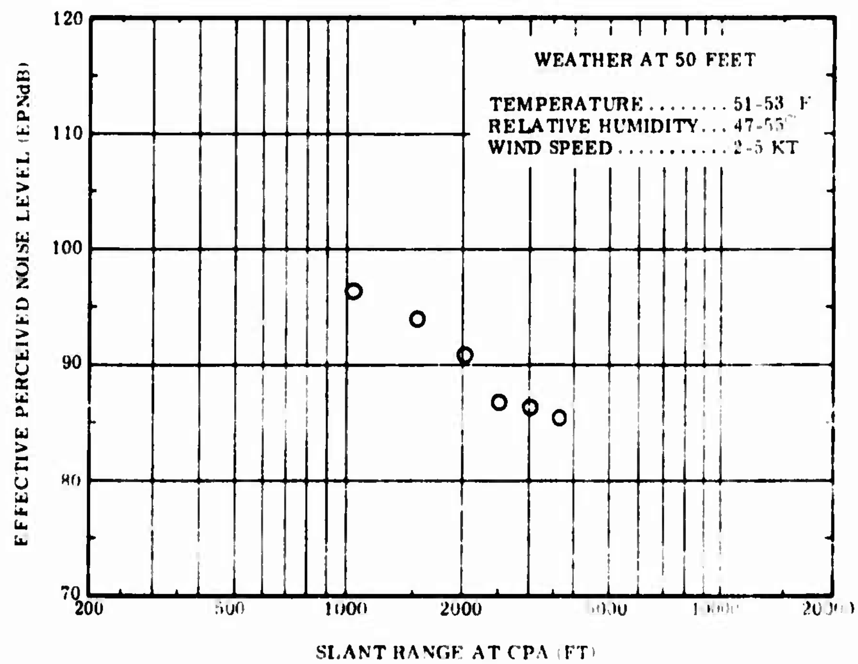


b. $\beta < 15°$; Z = 200 Feet

Figure 24. Noise Level of Sabreliner, 80- to 82-Percent Power

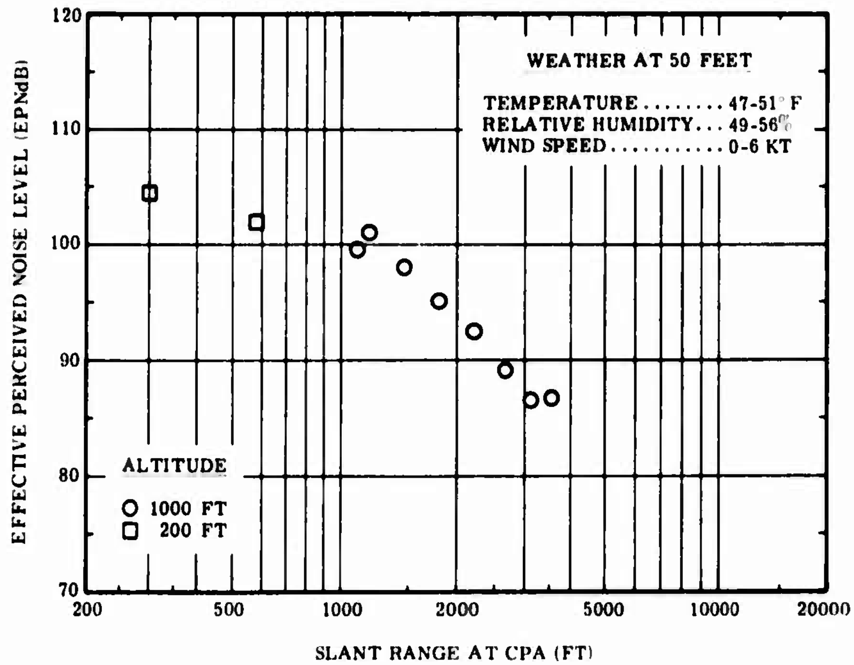


a. $\beta > 15°$; Z = 4500, 1000, and 200 Feet

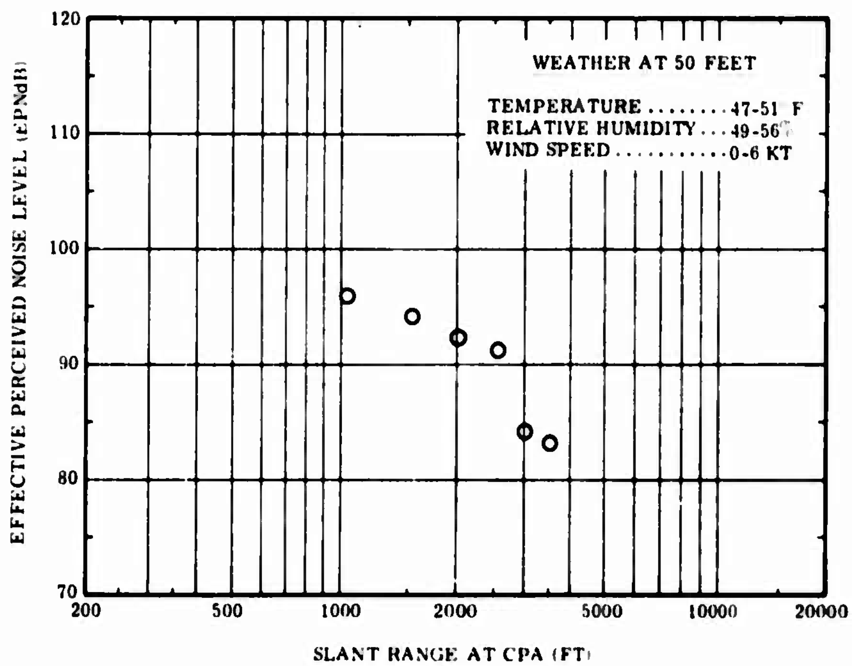


b. $\beta < 15°$; Z = 200 Feet

Figure 25. Noise Level of Sabreliner, 90-Percent Power

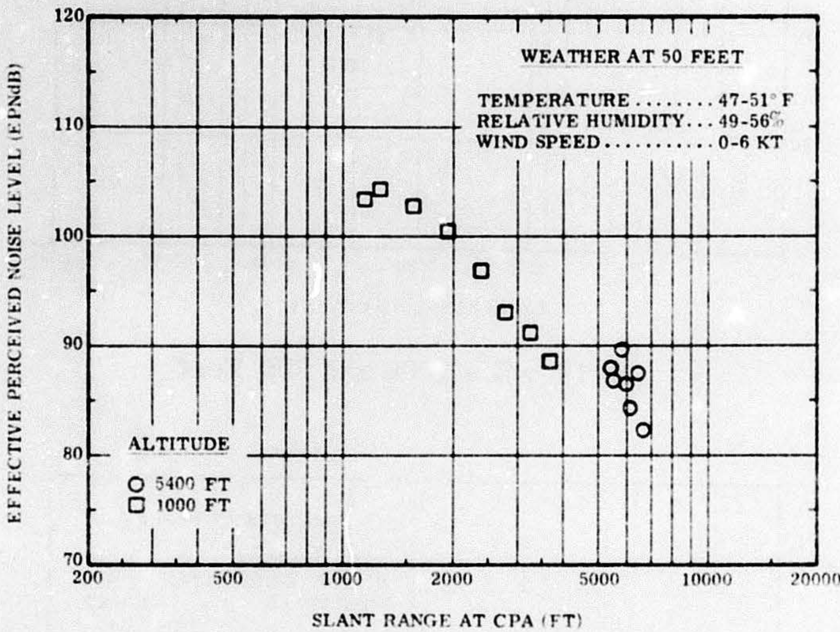


a. $\beta > 15°$; Z = 1000 and 200 Feet



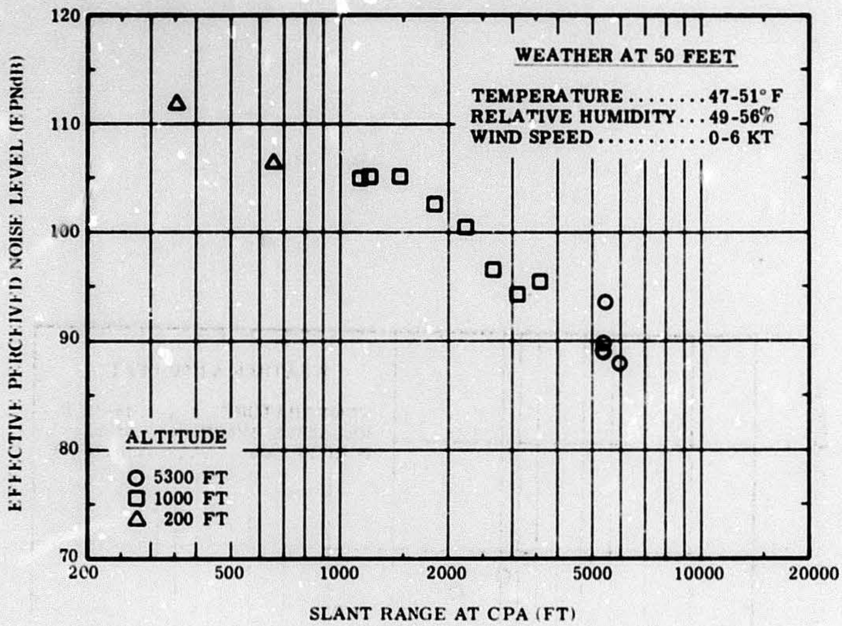
b. $\beta < 15°$; Z = 200 Feet

Figure 26. Noise Level of Jet Commander, 87.5- to 88.5-Percent Power

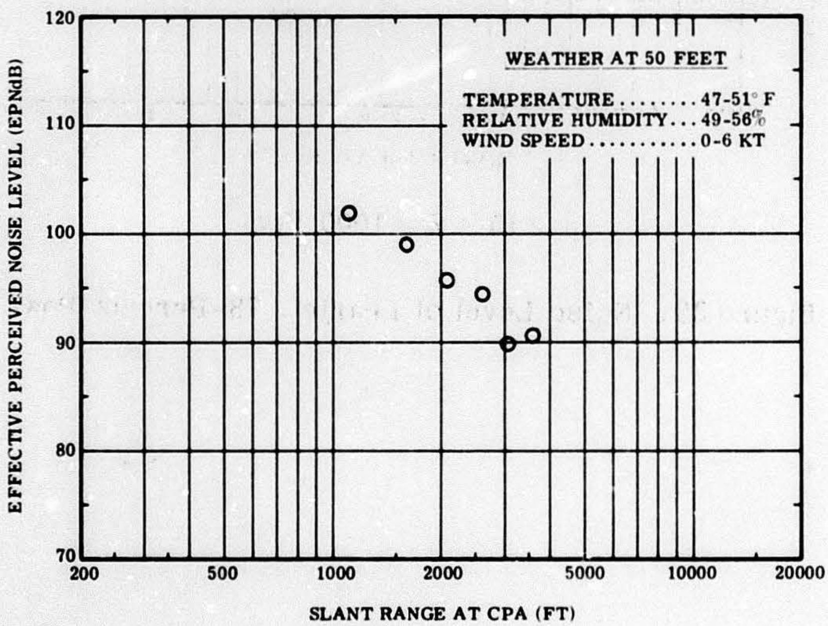


$\beta > 15°$; Z = 5400 and 1000 Feet

Figure 27. Noise Level of Jet Commander, 92-Percent Power

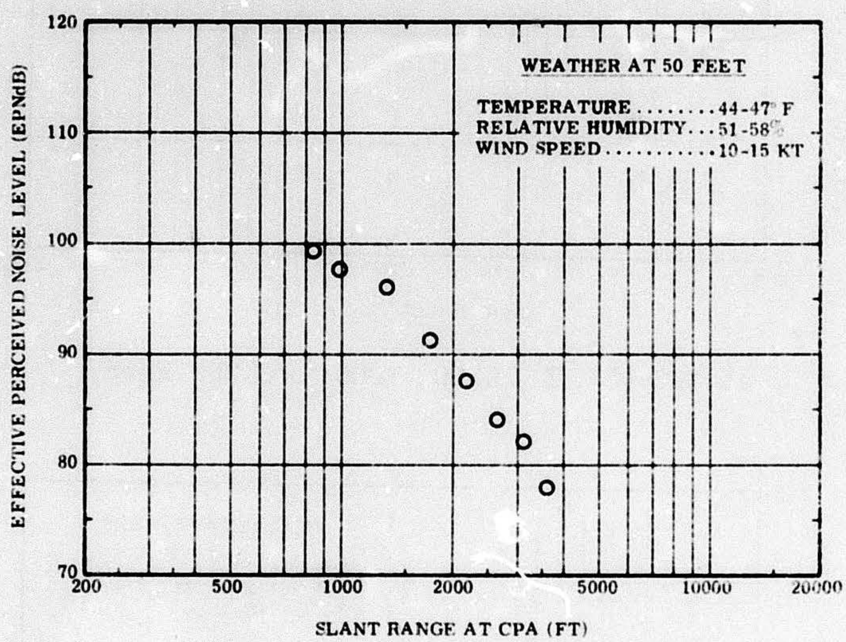


a. $\beta > 15°$; Z = 5300, 1000, and 200 Feet



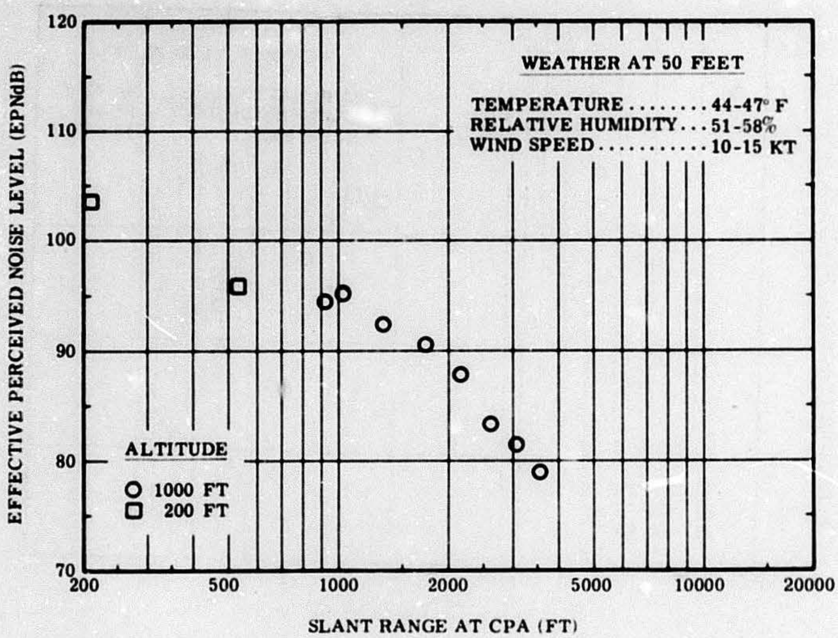
b. $\beta < 15°$; Z = 200 Feet

Figure 28. Noise Level of Jet Commander, 94- to 96-Percent Power

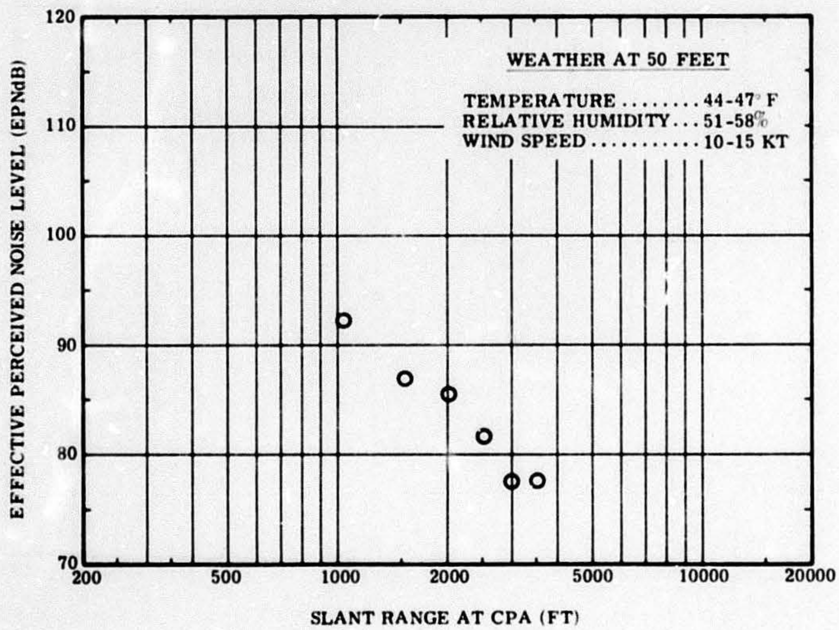


$\beta > 15°$; Z = 1000 Feet

Figure 29. Noise Level of Learjet, 78-Percent Power

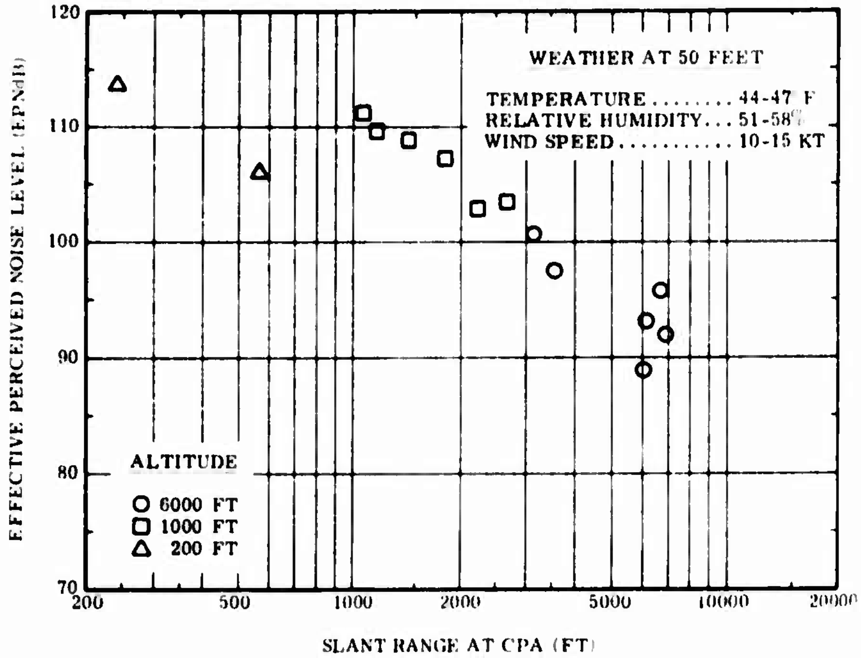


a. $\beta > 15°$; Z = 1000 and 200 Feet

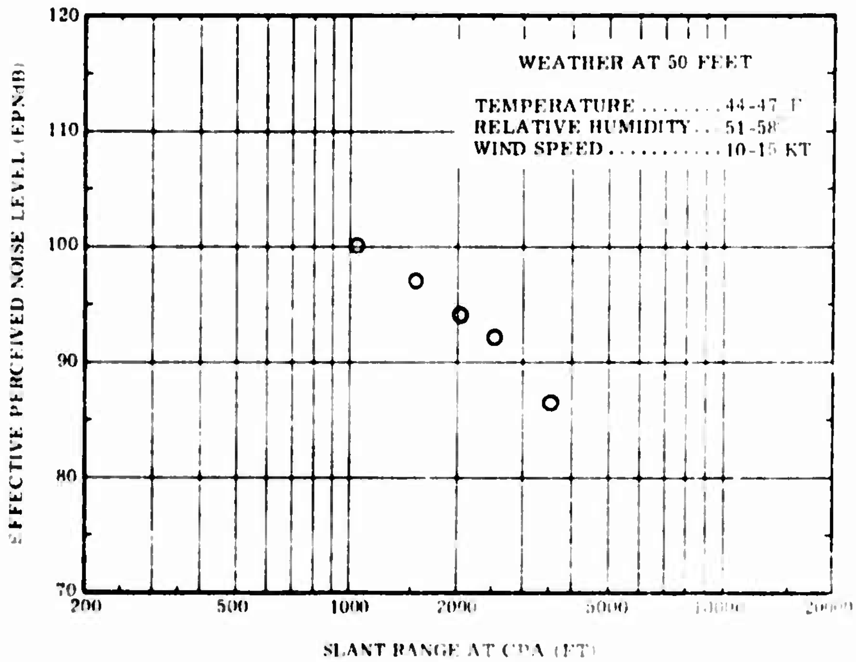


b. $\beta < 15°$; Z = 200 Feet

Figure 30. Noise Level of Learjet, 84- to 85-Percent Power

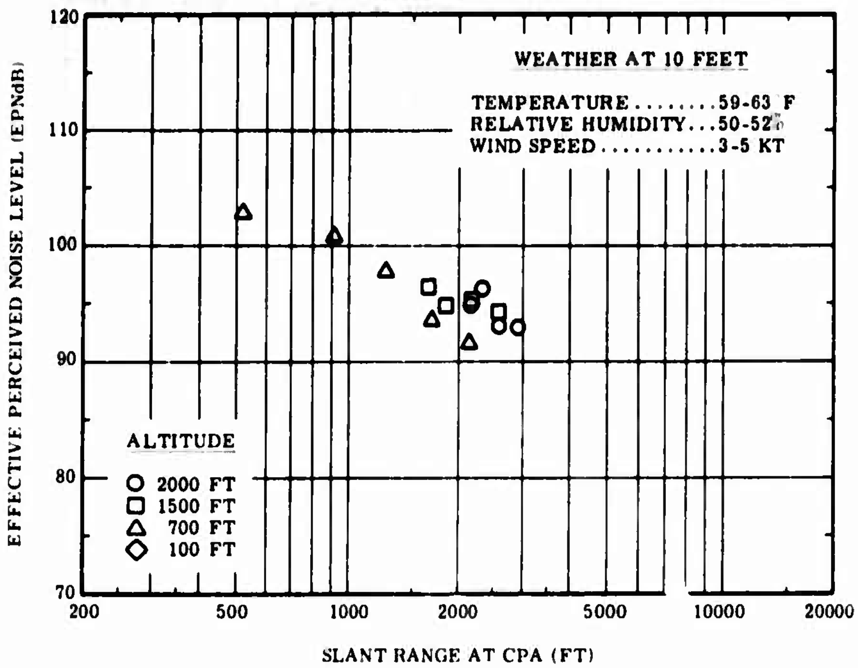


a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet

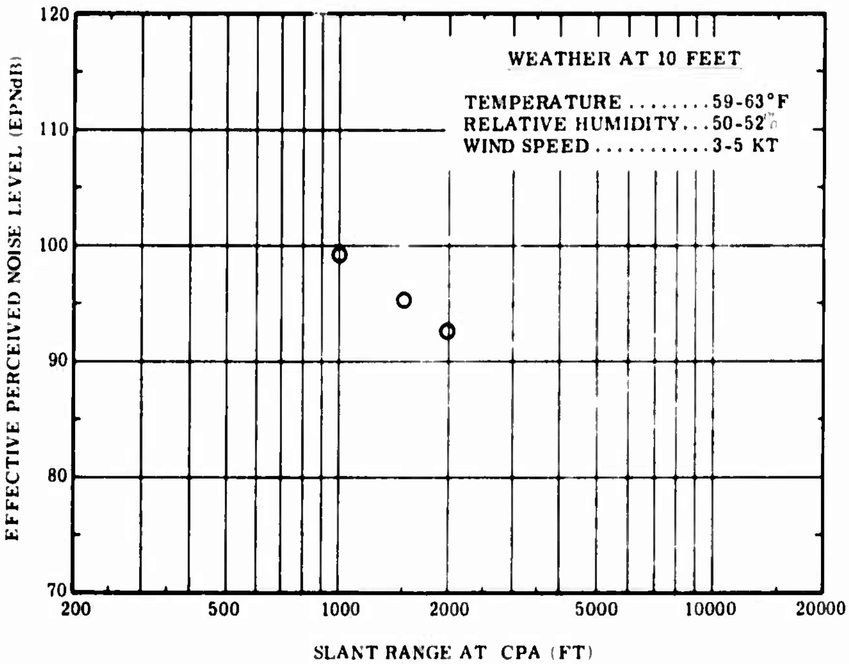


b. $\beta < 15$; Z = 200 Feet

Figure 31. Noise Level of Learjet, 100-Percent Power

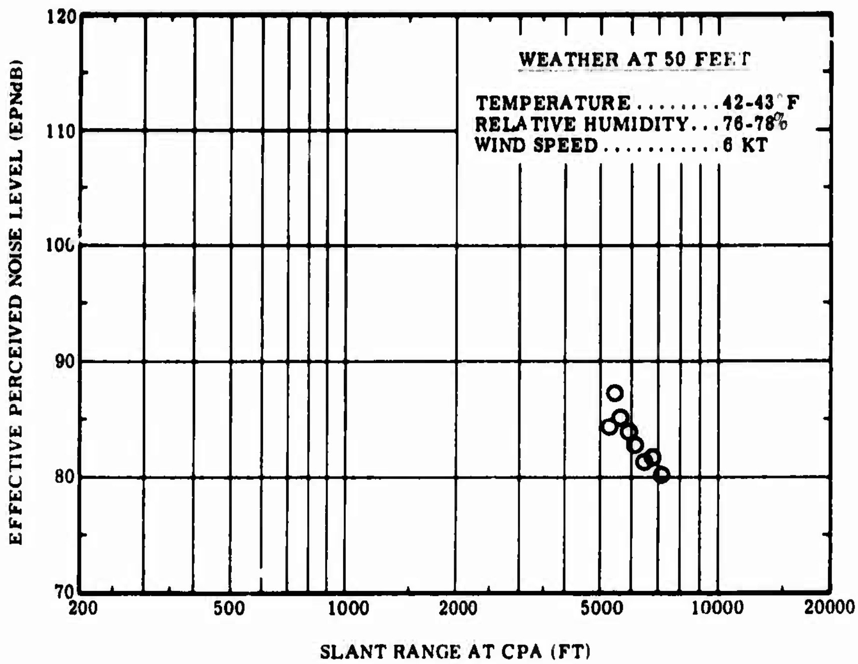


a. $\beta > 15°$; Z = 2000, 1500, 700, and 100 Feet



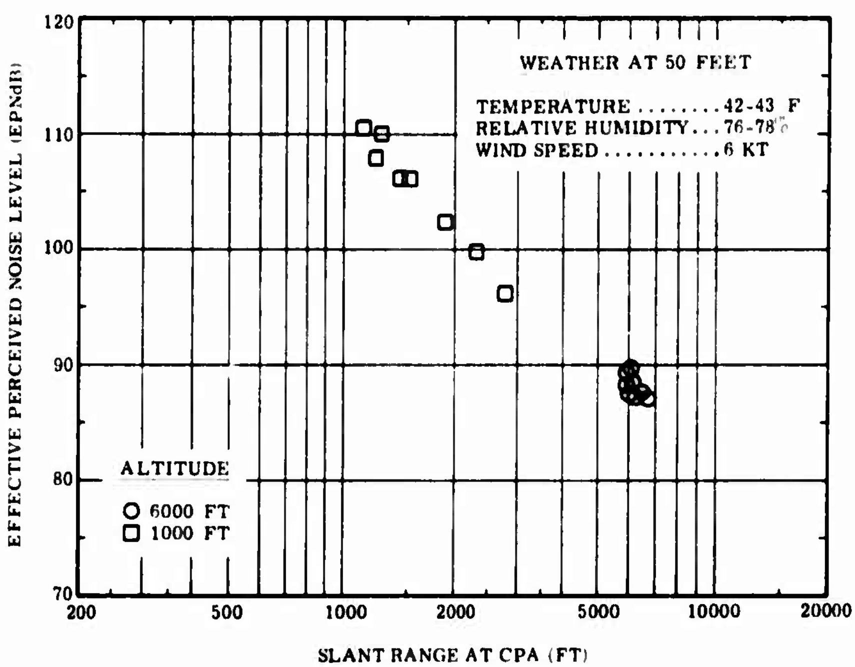
b. $\beta < 15°$; Z = 100 Feet

Figure 32. Noise Level of T-33, 100-Percent Power



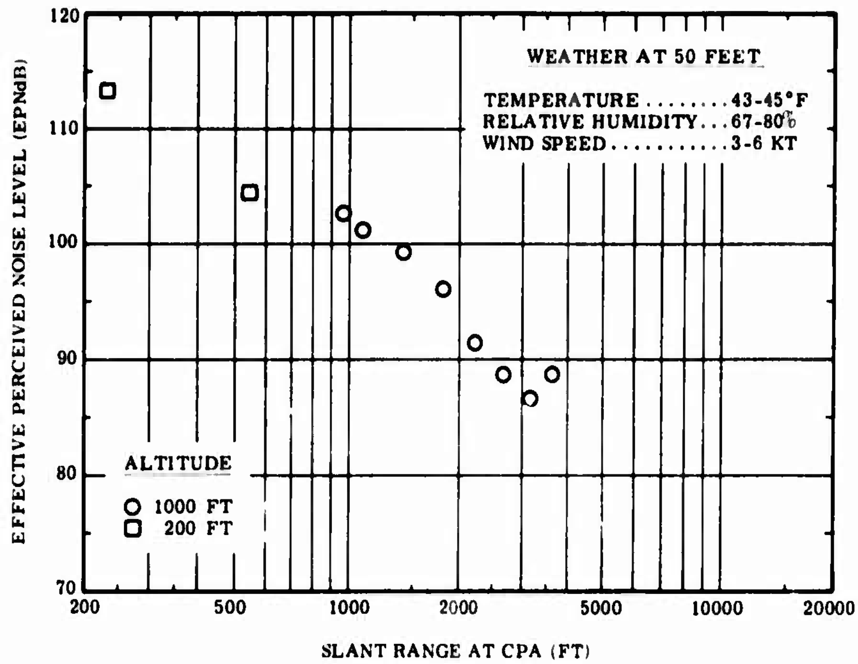
$\beta > 15°$; Z = 6000 Feet

Figure 33. Noise Level of C-141A, 75-Percent (Inboard)/ 88-Percent (Outboard) Power

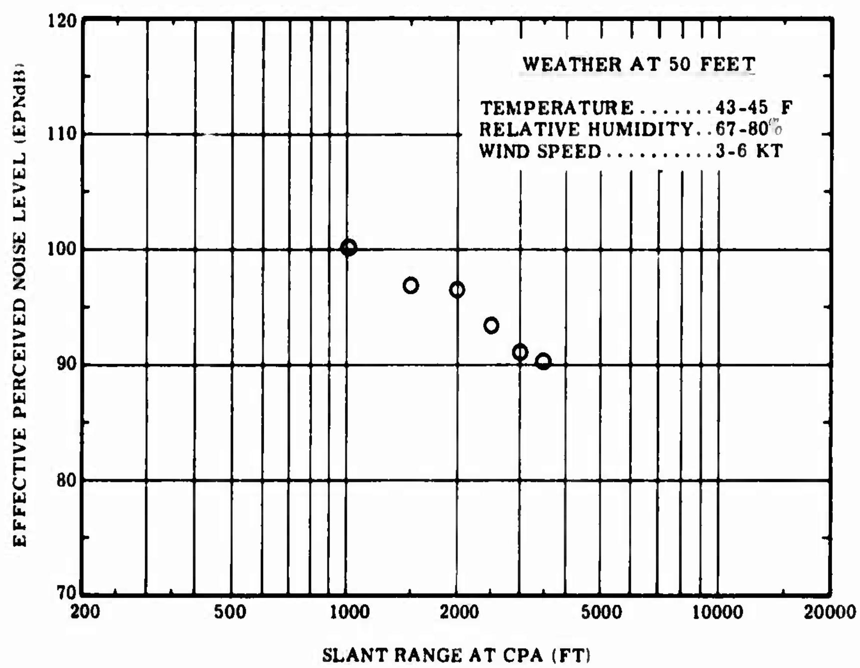


$\beta > 15°$; Z = 6000 and 1000 Feet

Figure 34. Noise Level of C-141A, 82- to 83-Percent (Inboard) 90- to 91-Percent (Outboard) Power

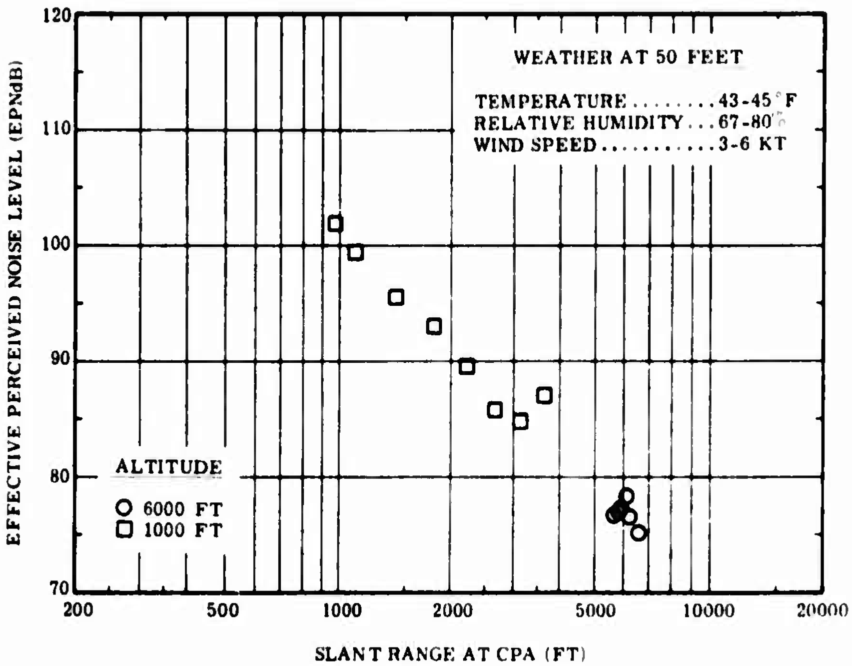


a. $\beta > 15^{\circ}$; Z = 1000 and 200 Feet



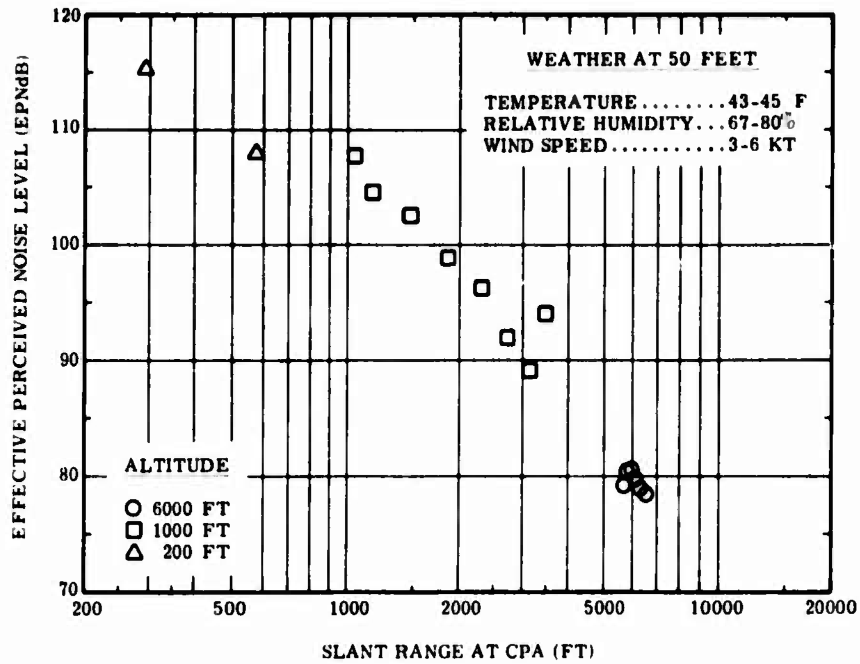
b. $\beta < 15^{\circ}$; Z = 200 Feet

Figure 35. Noise Level of A-7B, 85- to 86-Percent Power

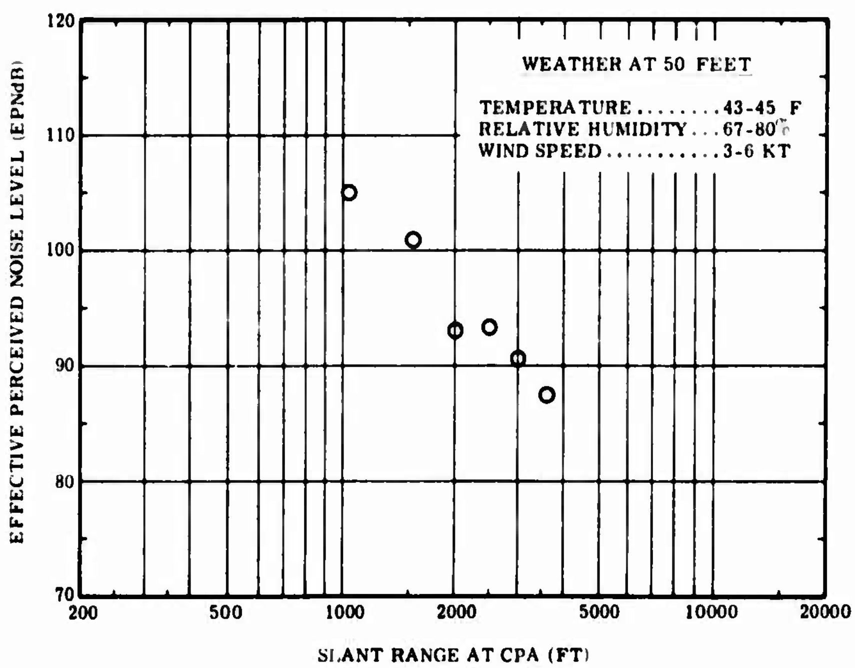


$\beta > 15°$; Z = 6000 and 1000 Feet

Figure 36. Noise Level of A-7B, 88-Percent Power

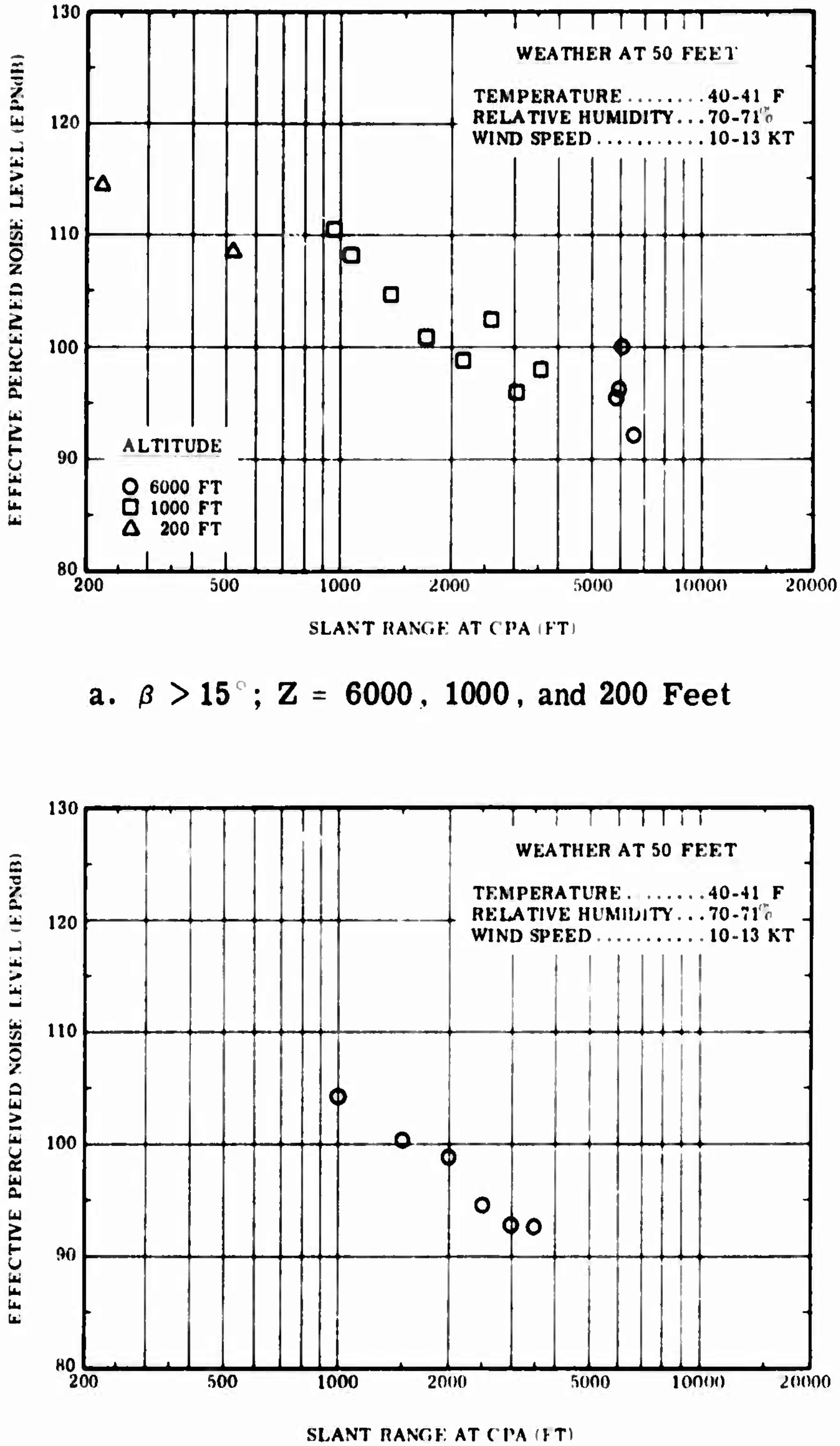


a. $\beta > 15^\circ$; Z = 6000, 1000, and 200 Feet



b. $\beta < 15^\circ$; Z = 200 Feet

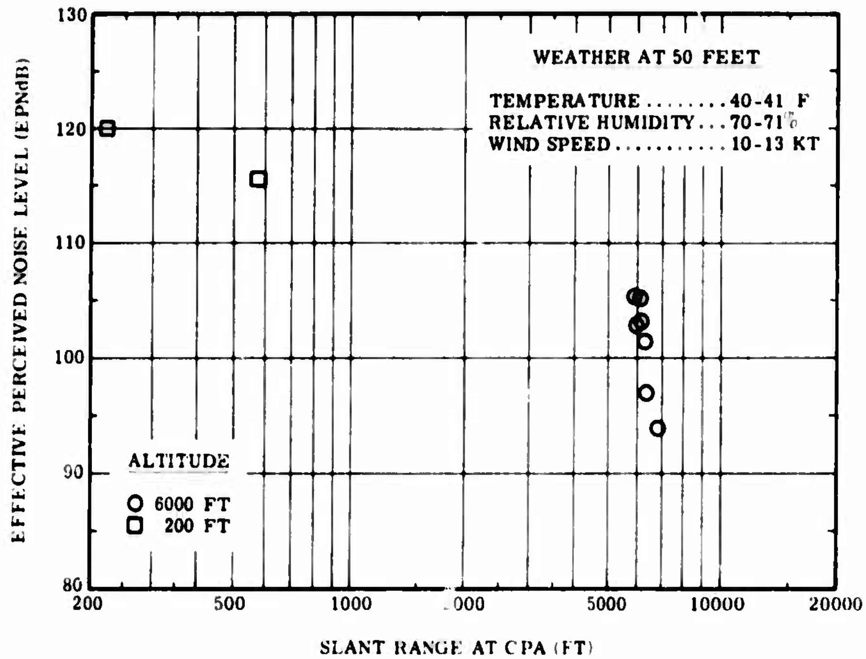
Figure 37. Noise Level of A-7B, 100-Percent Power



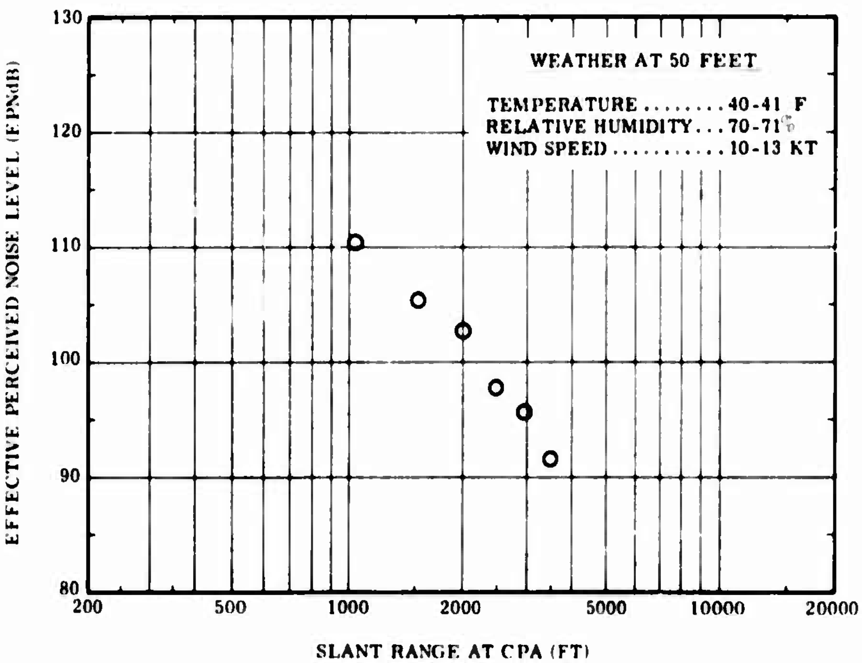
a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet

b. $\beta < 15°$; Z = 200 Feet

Figure 38. Noise Level of F-4, 85-Percent Power

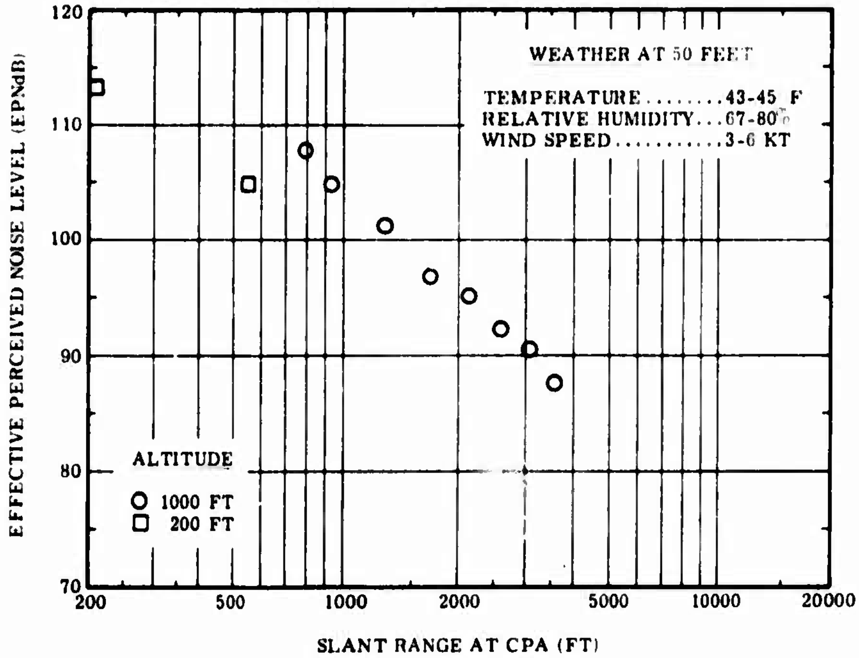


a. $\beta > 15^\circ$; Z = 6000 and 200 Feet

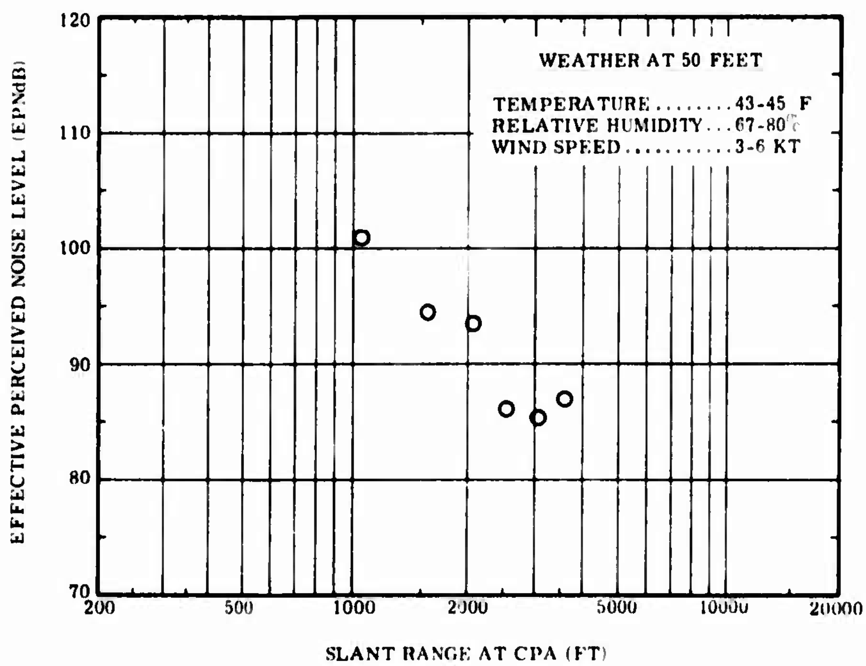


b. $\beta < 15^\circ$; Z = 200 Feet

Figure 39. Noise Level of F-4, 100-Percent Power

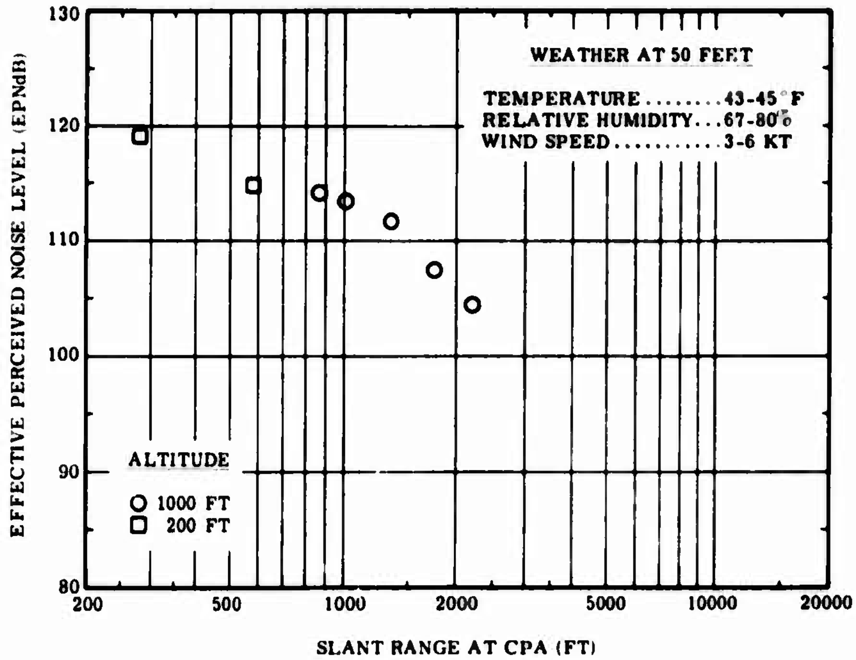


a. $\beta > 15°$; Z = 1000 and 200 Feet

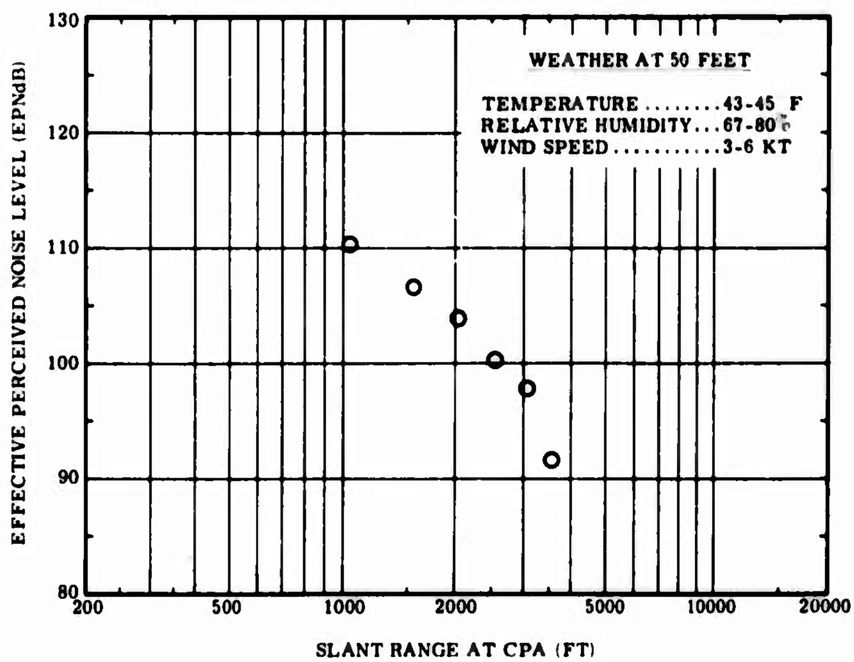


b. $\beta < 15°$; Z = 200 Feet

Figure 40. Noise Level of F-101, 86- to 87-Percent Power

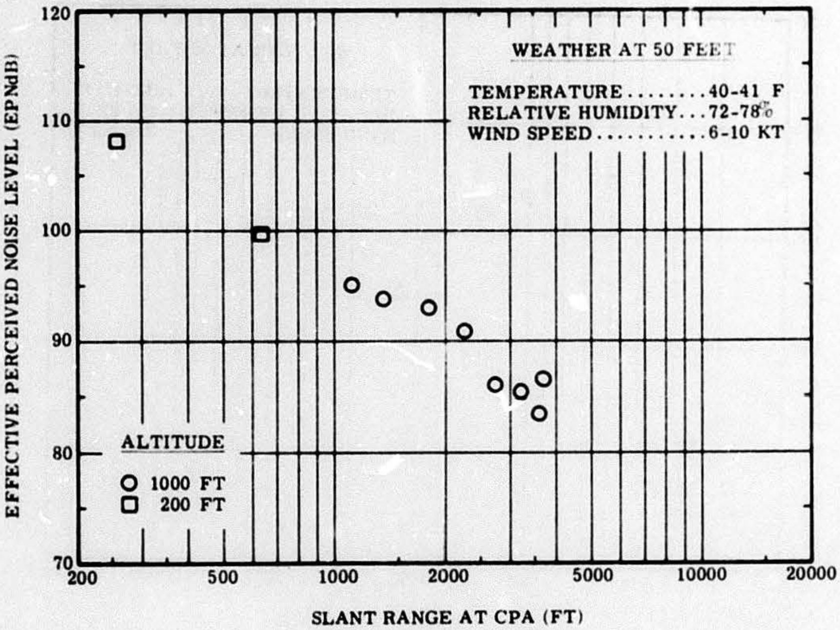


a. $\beta > 15^\circ$; Z = 1000 and 200 Feet

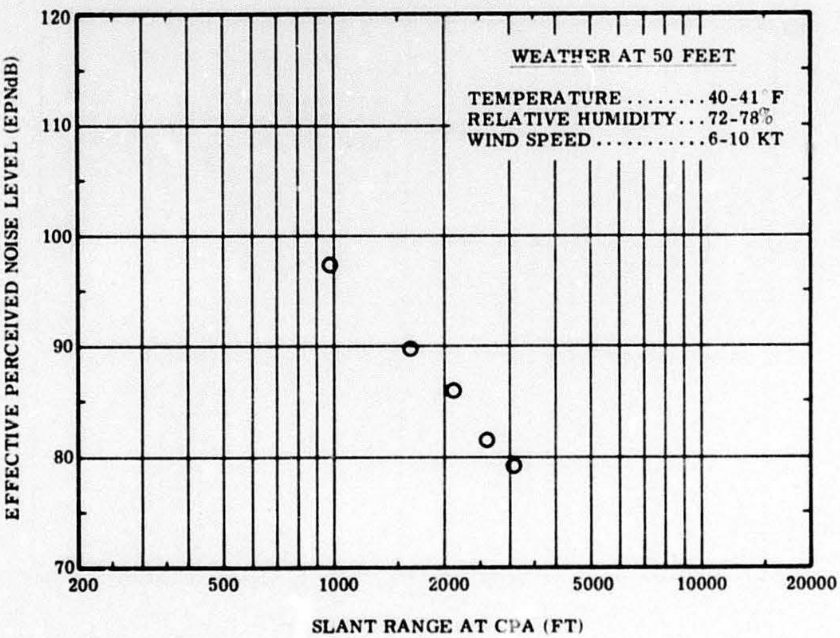


b. $\beta < 15^\circ$; Z = 200 Feet

Figure 41. Noise Level of F-101, 100-Percent Power

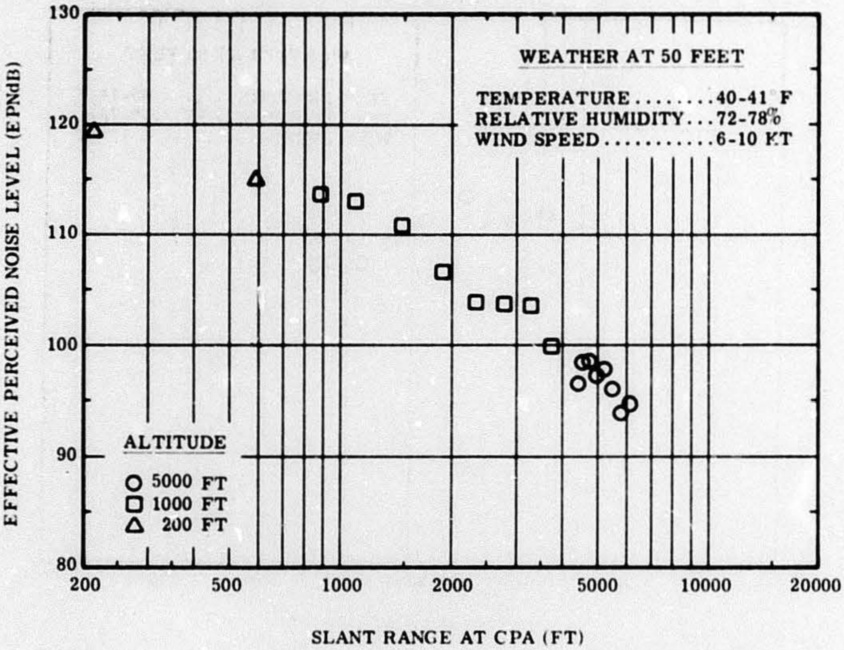


a. $\beta > 15°$; Z = 1000 and 200 Feet

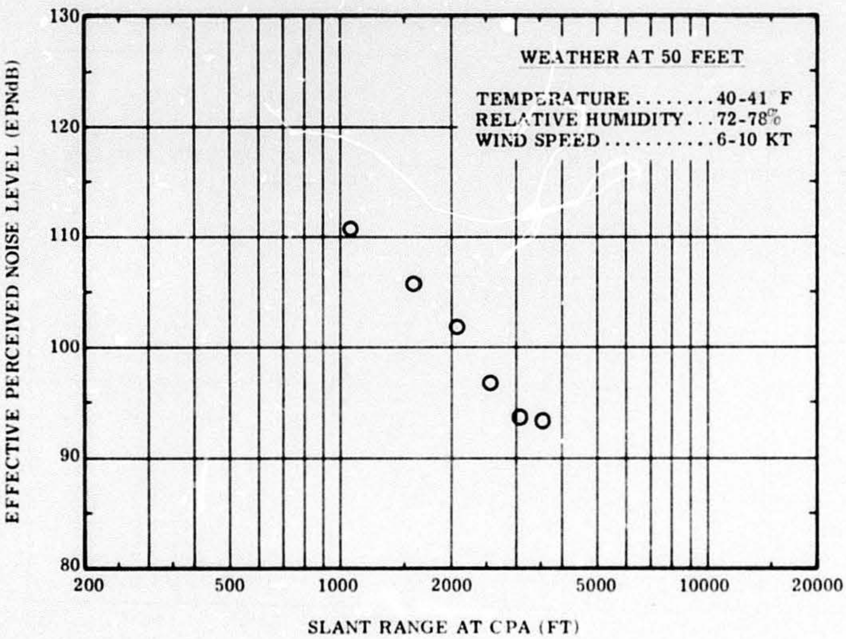


b. $\beta < 15°$; Z = 200 Feet

Figure 42. Noise Level of F-102, 55-Percent Power

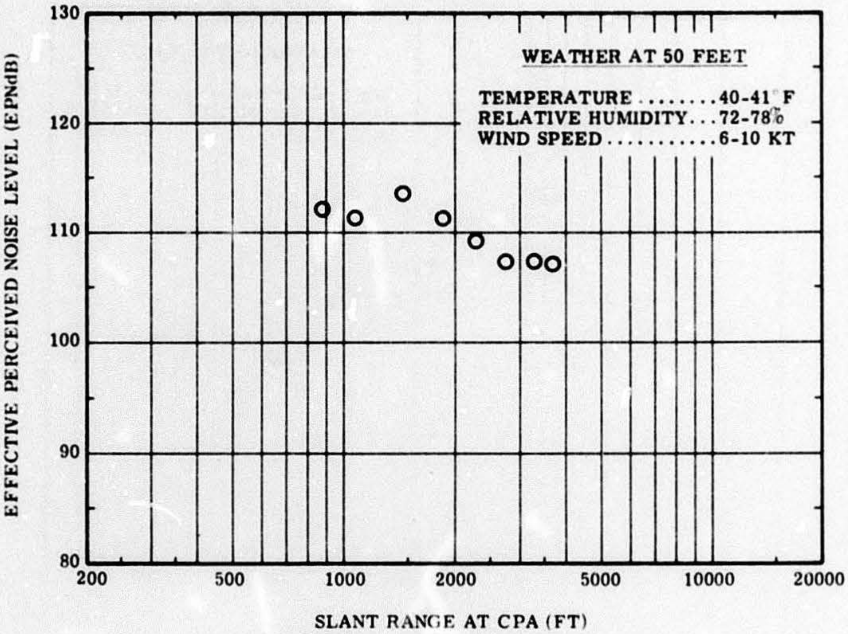


a. $\beta > 15°$; Z = 5000, 1000, and 200 Feet



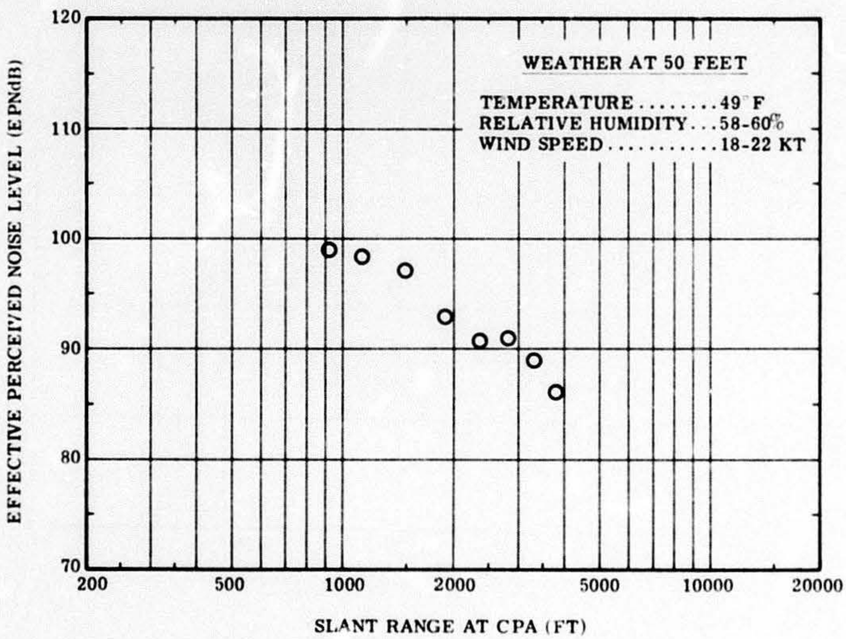
b. $\beta < 15°$; Z = 200 Feet

Figure 43. Noise Level of F-102, 100-Percent Power



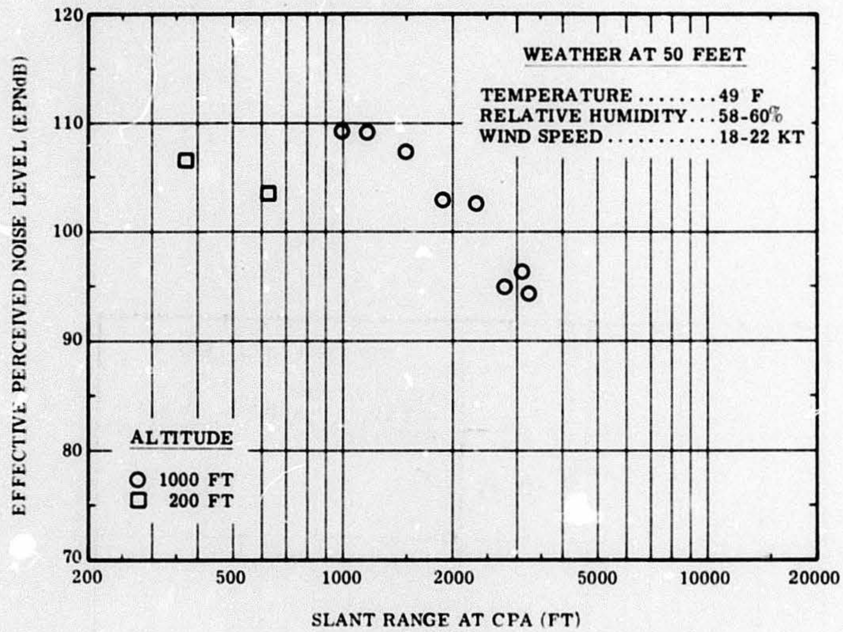
$\beta > 15°$; Z = 1000 Feet

Figure 44. Noise Level of F-102, Afterburner Power

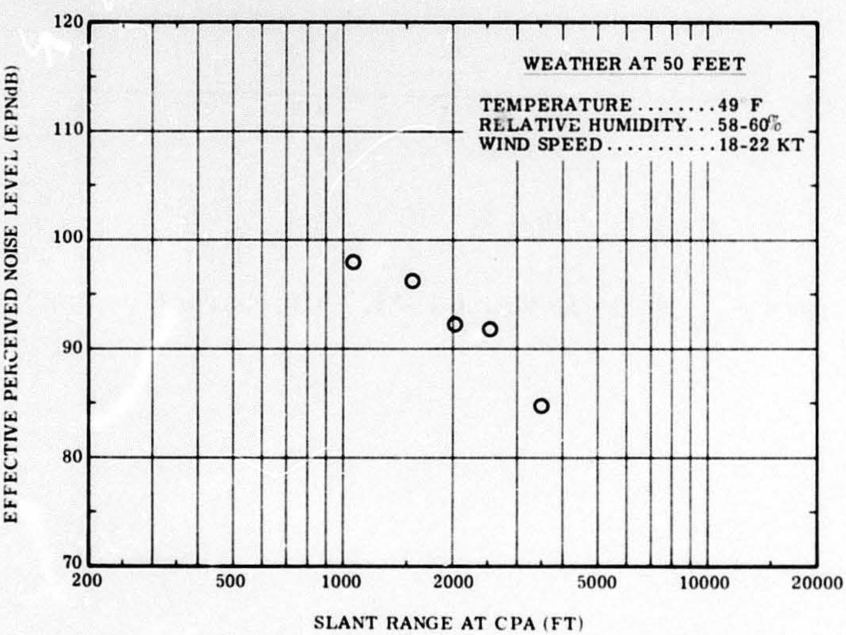


$\beta > 15°$; Z = 1000 Feet

Figure 45. Noise Level of F-8K, 93-Percent Power

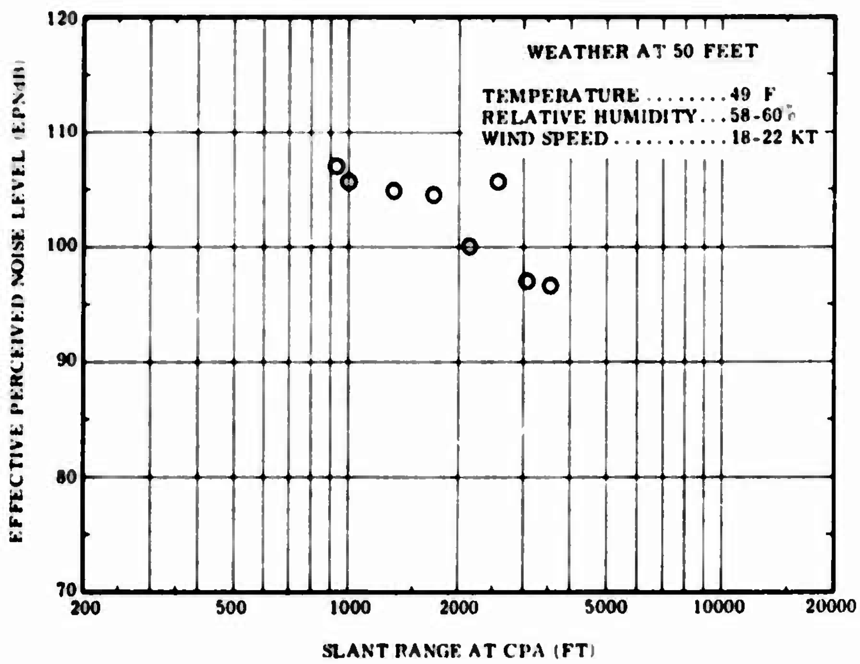


a. $\beta > 15^\circ$; Z = 1000 and 200 Feet



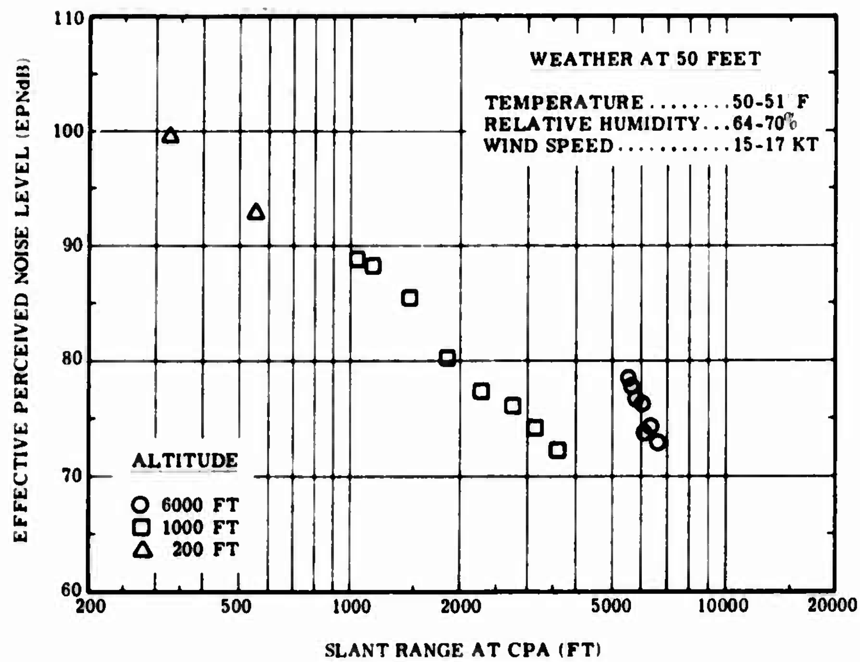
b. $\beta < 15^\circ$; Z = 200 Feet

Figure 46. Noise Level of F-8K, 96- to 97-Percent Power

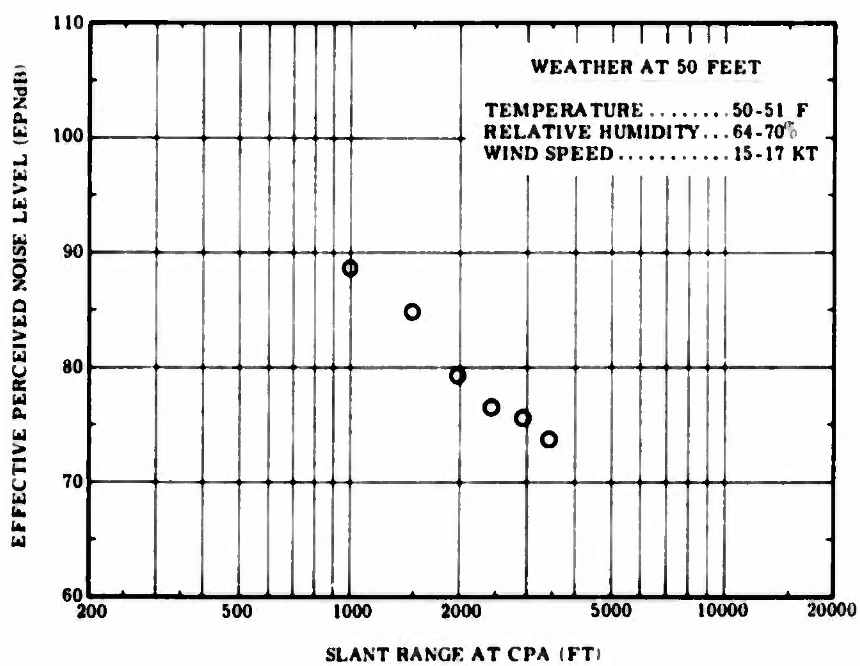


$\beta > 15°$; Z = 1000 Feet

Figure 47. Noise Level of F-8K, Afterburner Power

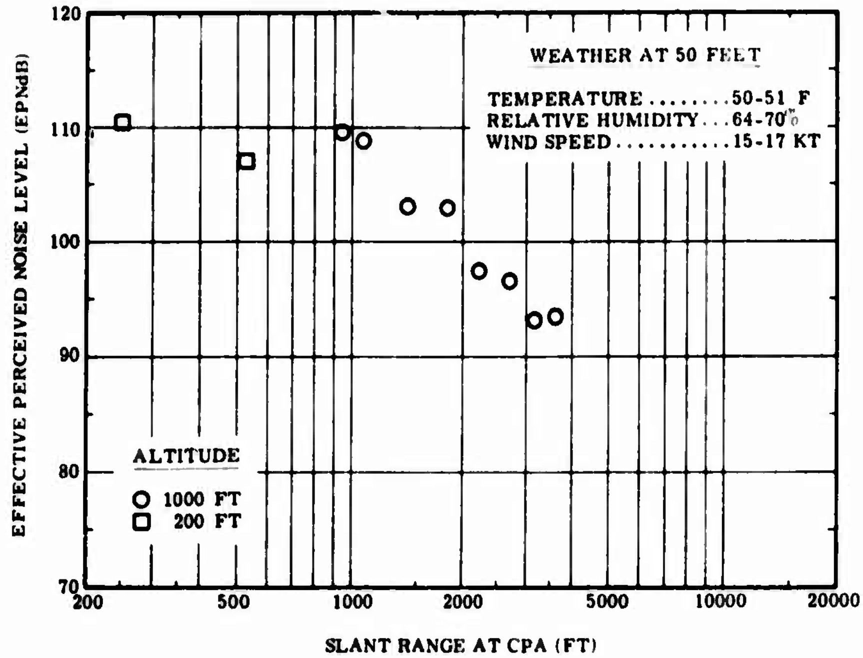


a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet

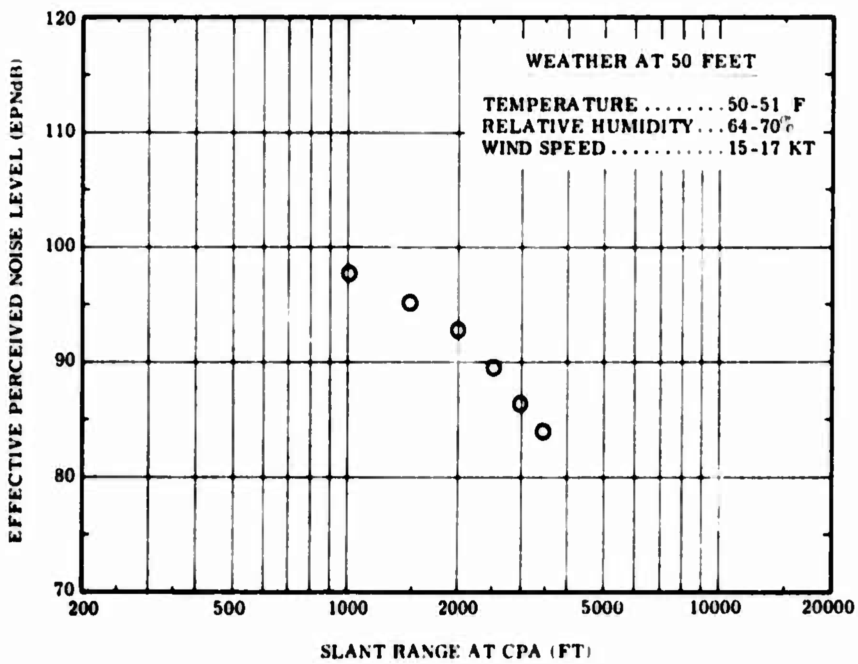


b. $\beta < 15°$; Z = 200 Feet

Figure 48. Noise Level of A-6A, 75-Percent Power

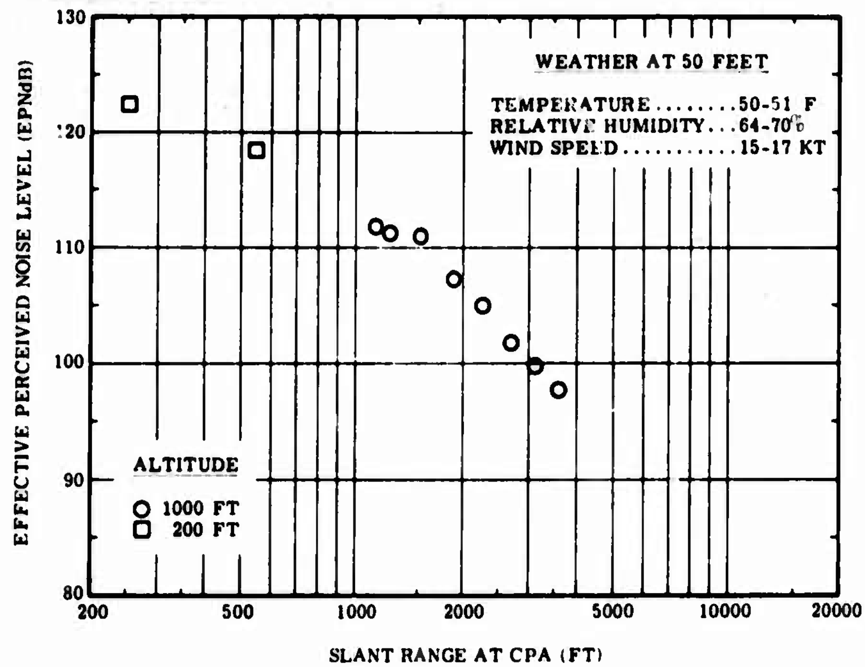


a. $\beta > 15°$; Z = 1000 and 200 Feet

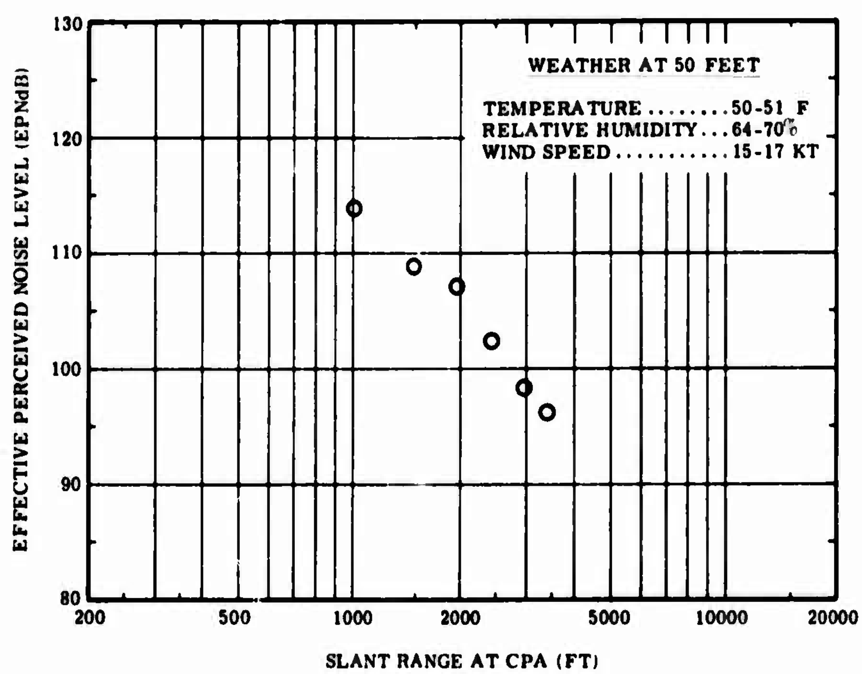


b. $\beta < 15°$; Z = 200 Feet

Figure 49. Noise Level of A-6A, 87- to 89-Percent Power

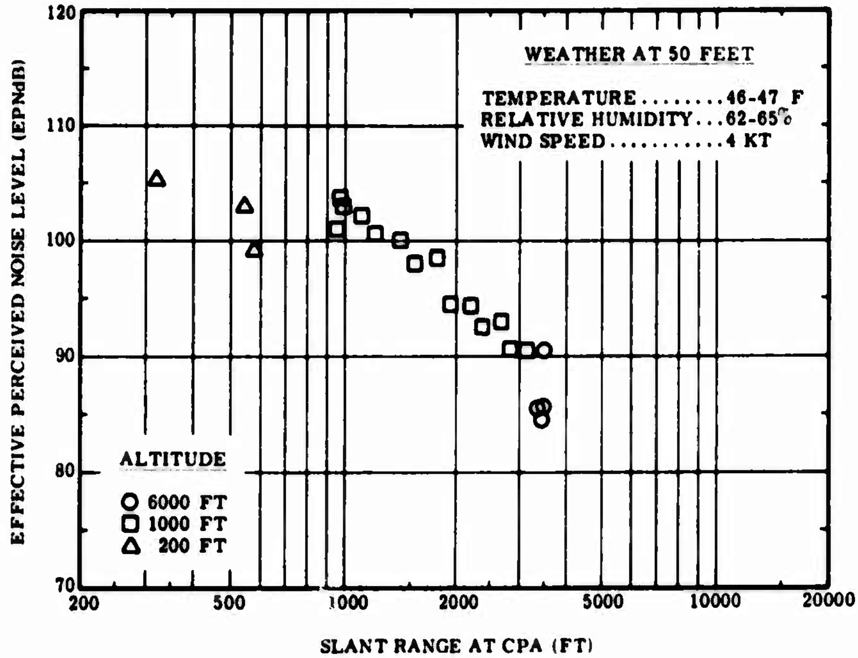


a. $\beta > 15°$; Z = 1000 and 200 Feet

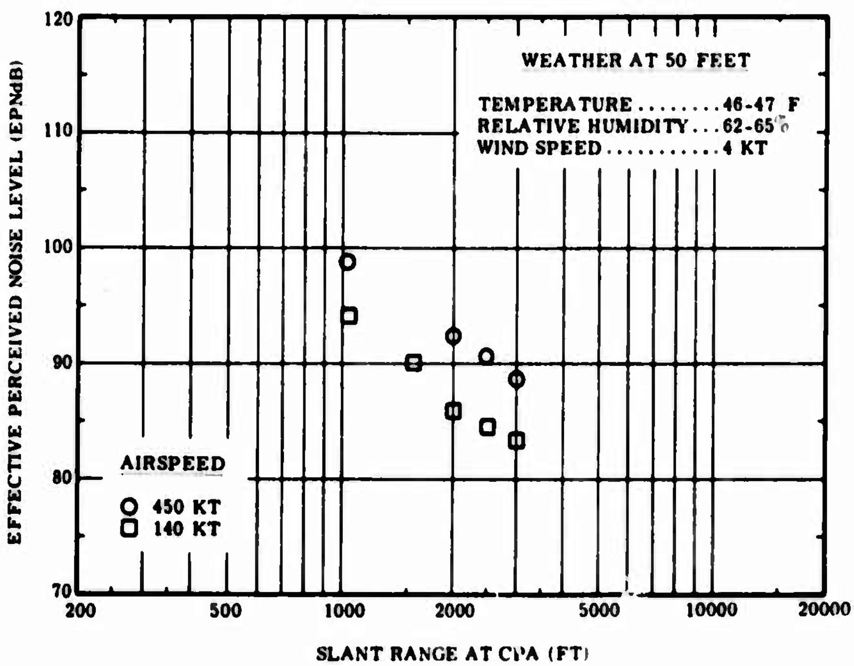


b. $\beta < 15°$; Z = 200 Feet

Figure 50. Noise Level of A-6A, 98- to 100-Percent Power



a. $\beta > 15°$; Z = 6000, 1000, and 200 Feet



b. $\beta < 15°$; Z = 200 Feet

Figure 51. Noise Level of A-4C, 75-Percent Power

SUMMARY

Data is presented for a series of level flybys of military, business jet, and general aviation aircraft. Plots of effective perceived noise level as a function of slant range at the closest point of approach are presented for elevation angles greater than 15 degrees and less than 15 degrees. This information can be used to estimate flyover noise levels for a variety of engine power settings and aircraft types.

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